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THE GRAVE SPINAL CORD PARALYSES CAUSED BY SPINAL ANESTHESIA

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IN 1945 three verified cases of spinal arachnoiditis and paralysis following spinal anesthesia were reported (44) from the Neurological Service of Bellevue Hospital. An attempt was made at that time to bring these and other sequelae to the attention of surgeons and anesthetists. The incidence of these sequelae has not diminished. Unfortunately, it is not generally known, and still less widely accepted, that spinal anesthesia may result in temporary or permanent neurological complications: paralyses or continuing nerve root pain.

Since Pitkin introduced his so called "controllable" spinal anesthesia in 1928, this method of anesthesia has come to be almost a routine procedure for many surgeons and some hospitals, sometimes without adequate consideration of the patient, the character of the surgery, and certainly with little conscious regard for possible complications. In 1933, Foss and Schwalm wrote, "Spinal anesthesia can be used . . . in operations below the diaphragm with far greater safety than most surgeons at present seem to believe." In 1947, Ericsson provided the prevailing opinion: "Spinal anesthesia appears in increasing degree to have few or no contraindications."

The literature contains many contradictory reports concerning the incidence of complications. Orth (1925), Babcock (1928), Pitkin (1929), Foss and Schwalm (1933), Forgue (1934), Sebrechts (1934), Emmet (1935), and Lundy (1942) deny that spinal anesthesia properly performed could result in any complications.

On the other hand, Urban mentioned complications as early as 1907, and Kaiser reported further after-effects in 1921. Lindemulder (1932) wrote, "It must be recognized that there may be certain definite residuals after spinal anesthesia." Jarmen (1934) gives an incidence of paralysis of 0.01 per cent; Hyslop (1933) reports an incidence of central nervous system sequelae as 0.5 per cent; Nicholson and Eversole (1946) found 0.024 per cent of neurological complications at the Lahey Clinic; and Schildt (1947) reports an incidence of complications as 0.01 per cent. Minnit and Gillies write, "To say that one has not seen these complications is only half an answer, because one has probably not looked for them."

These neurological complications have been discussed in numerous reports in the literature. They may occur immediately in association with the spinal anesthesia or after an interval of time when they are not recognized as being associated with the spinal anesthetic. At the Swedish Central Hospital in Orebro, the complications were considered to be rare until Gunnar Thorsen made his compre-

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hensive study in 1947 and now "this point of view is changed." Thorsen states, "They are not rare and not negligible." Schildt adds, "From the use of any of the present-day spinal anesthetics there may follow serious nervous symptoms which depend upon (probable chemotoxic) injuries of the spinal cord or its membranes." Madan (1944) writes, "There is still a lack of perfect controllability and safety and there is a lack of thorough knowledge."

Spinal anesthesia was first produced in 1885 by Corning in man and dogs. Fourteen years later Bier introduced spinal anesthesia with cocaine for clinical surgery. However, cocaine was too toxic and its use was discontinued. In 1903 Fournier developed stovaine, and in 1904 Einhorn produced novocain. Since then, numerous other derivatives or combinations have been prepared. All are toxic in varying degree.

Animal experiments carried out by Van Lier (1907), Wossidlo (1908), Spielmeyer (1908), Klose and Vogt (1909), Davis, Haven, Given, and Emmet (1931), Lundy, Essex, and Kernohan (1933), and Macdonald and Watkins (1937) resulted in agreement that the etiological toxic agent is the anesthetic substance, though there is disagreement as to the specific mode of action. The injuries are located in the spinal cord most marked near the site of injection; the nerve roots and spinal ganglia are often spared. There are: (1) constant but varying degrees of meningeal reaction with cellular proliferation and infiltration which may progress to cicatrization; (2) changes in the ganglion cells of the gray matter with "swelling, rounding, chromatolysis, achromatosis, and disappearance of cell fibrils"; (3) swelling and fragmentation of the axis cylinders of the nerve roots, especially in the posterior and lateral columns together with degenerative changes in the fiber tracts of the spinal cord, most marked below the lower dorsal segments of the cord; (4) peripheral degeneration of the myelin sheath of the spinal cord. The pathological changes seen in these animal experiments are the same as those seen at operation or post mortem in patients who have had complications after spinal anesthesia.

In 1927, Franke reported a case with marked leg weakness, sensory disturbance, and difficulties with micturition and defecation after spinal anesthesia with novocain. The patient died of pneumonia on the sixth postoperative day. Postmortem examination revealed swelling of 2 inches of the lumbar region of the cord, with a somewhat softer area above. Hemorrhages were found up to the medulla. Microscopic examination detected hemorrhage and damage of the myelin sheaths. Lindemulder (1932) described inflammatory changes in the leptomeninges and brain substance in 2 patients who died soon after spinal anesthesia. Brock, Bell, and Davison (1936) found in a patient with total flaccid paralysis of both legs produced by spinal anesthesia: "extensive destruction of the myelin sheath, axis cylinders and glia, mostly at the periphery of the cord and at the zones of entrance of the posterior roots. The ganglion cells of the anterior and lateral horns were also slightly involved." Kamman and Baker (1943), with a similar clinical result immediately after spinal anesthesia, found an adhesive leptomeningitis of the middle and lower thoracic segments of the spinal cord. In some areas the pia-arachnoid was hyalinized. In this area of the cord, the posterior columns were replaced by a large area of softening. The remaining white and gray matter was severely damaged. Demyelinization was prevalent in the lateral and posterior columns in and below the lower thoracic segments. Ferguson and Watkins (1937), in autopsies on 3 cases of cauda equina syndrome, found on cord sections "some increased hyaline changes in the vessel walls and in addition some marginal pallor of the cord in the sacral region, but no other definite changes. Marchi sections were negative. Sacral nerves showed fine vacuolation and evidence of recent degeneration." Critchley (1937) described a case of spinal cord softening following spinal anesthesia. A week after the administration of 2 cubic centimeters of spinocaine in the third lumbar interspace his patient developed back pain. One month later there occurred motor and sensory paralyses. On pathological examination there was massive softening of the spinal cord, maximal at the level of the upper lumbar enlargement. The veins in the affected areas showed endophlebitis or thrombosis, while arteries showed signs of acute necrosis or "necrotizing arteritis."

Except for Sebrechts, there is general agreement that bilateral headache, localized especially to the forehead and behind the eyes, occurs following both simple lumbar puncture and spinal anesthesia. Some authors claim the incidence is about the same in both, while others believe the incidence is greater after spinal anesthesia. In addition, there is "greater liability to a severe and protracted course (of headache) and to occasional development of complicating features (80) after spinal anesthesia. The frequency of these varies considerably. Koster and Weintraub (1930) report 10 per cent of 6,000 cases. Ashworth (1933) found it in 4.9 per cent of 184 cases. Falk (1931) reported an incidence of 6 per cent. Hingson, Ferguson, and Palmer (1943) reported an incidence of 1 per cent of 5,150 patients. Thorsen (1947) in a compilation of over 50,000 cases cites the frequency as approximately 18 per cent. The etiology must be primarily related to the mechanics of lumbar puncture plus the additional effect of the anesthetic agent. The primary cause in most cases seems to be a leakage of cerebrospinal fluid with possible alteration of the spinal fluid dynamics. Approximately 80 per cent of patients with headache after spinal anesthesia have lowered spinal fluid tension. This is rather more common in women. Also, there is a statistical difference in age groups, headache being more common before the ages of 40 to 50. In approximately 60 per cent of the patients with headache, there is the added complaint of dizziness. In a small number of cases this symptom occurs alone.

Aseptic, purulent, and chronic adhesive meningitis have been reported to occur after spinal anesthesia. Aseptic meningitis is characterized by fever, stiff neck, headache, and the presence of a Kernig sign. Spinal fluid examination shows an increased number of cells, but normal sugar and no organisms. This clinical picture is seen to begin almost immediately or within 60 hours postoperatively. Such meningeal reaction is usually mild and transient, though stupor and delirium may occur. The increased number of cells rapidly returns to normal and the spinal fluid protein also returns to normal if it had been elevated. A total of 49 cases has been reported to date, and Orkin in a summary of 45,966 cases of spinal anesthesia by 20 authors gives an incidence of 0.26 per cent.

A considerable number of cases of purulent meningitis have been described following spinal anesthesia. It is said to occur in a proportion of approximately 1 case to every 800 spinal anesthesias (71). Meningococci were implicated in 2 cases, pyocyaneus in 4 cases, streptococci in 5 cases, tubercle bacilli in 2 cases, and spore-bearing rods and coli have also been responsible (71). This complication was fatal in each case until the appearance of antibiotic drugs. Though it was not the direct result of the anesthetic agent, it did occur as a complication of the procedure.

However, severe progressive complications are sometimes seen as the result of the already described chronic type of leptomeningitis with formation of adhesions and thick cicatricial bands. The postmortem findings in the case reported by Kamman and Baker have been described. Hammes (1943) reported 2 patients with a syndrome of a slowly ascending myelitis who were found to have a cerebrospinal fluid block. Exploratory laminectomy in 1 of these cases revealed pachymeningitis. Hewer (1933) described a patient, who was found at laminectomy 9 months after administration of 15 cubic centimeters of 1:1500 percaine in the first lumbar interspace, to have a constricting band of adhesive arachnoiditis about the lower part of the cord and upper part of the cauda equina. Haynes and Smith (1942) reported the case of a 24 year old man who developed the clinical signs of cervical cord involvement 4 days after use of a pontocaine glucose solution as a spinal anesthetic. Cervical laminectomy 2 months later revealed a cervical arachnoiditis; some improvement followed lysis of many adhesions. The operative findings in 3 cases were described by one (44) of us in 1945. Thorsen has found 26 other cases in the literature, including Weigeldt's report of a patient who developed flaccid paraplegia 3 months after spinal anesthesia. Pathological examination revealed intense adhesions extending caudally from a point 11 centimeters below the olivary body.

Even cerebral injuries have been reported in association with spinal anesthesia. These cases

have been considered to be nonspecific and not directly related to the anesthetic agent. The vasoconstrictor paralysis which occurs through blocking of the anterior nerve roots produces a sudden fall of blood pressure and diminution of cardiac output. Hingson and associates believe this occurs only when the level of anesthesia extends above the eighth thoracic spinal cord segment. The fall in blood pressure is responsible for a cerebral anoxia. This is sometimes further increased by impaired respiration and may lead to changes in consciousness, personality, hemiplegia, hemiparesis, convulsive disorders, and like conditions.

Several authors have reported convulsive disorders with or without hemiparesis occurring 5 to 15 days after spinal anesthesia. Arnheim and Mage (1931) describe 3 cases of hemiplegia which occurred 1 and 3 days after operation and in which the patient died 3, 7, and 10 days later. Dickson Wright (1933) in a discussion of Ashworth's paper mentioned 2 cases of acute mania after the administration of 8 cubic centimeters of 1:1000 percaine. Critchley (1933) thought cerebral angiospasm or a small thrombosis due partly to an associated vascular disease was responsible for the mental confusion and transient hemiplegia occurring immediately following spinal anesthesia. Behrend and Riggs (1940) reported 21 fatal cases due to cerebral damage. Pathological findings in these cases correspond closely to those found in animal anoxia experiments. Belinkoff (1945) reported 4 cases with coma developing as an acute collapse associated with a sudden fall of blood pressure.

Encephalitis has been described following spinal anesthesia. Maclachlan (1931) described the case of a 38 year old woman who developed an encephalitis on the fourth postoperative day after a hysterectomy for fibroids. Brock, Bell, and Davison (1936) also presented a similar case of encephalitis. In both cases there were permanent residual signs. Donovan, Beretevide, and Rechniewoski (1928) and Hyslop (1933) described cases of meningoencephalitis. Martin (15), in 1937, reported a case of ascending myelitis following spinal anesthesia which eventually progressed to affect the brain.

The cranial nerves, with the exception of the first, ninth, tenth, and eleventh have been reported involved either singly or infrequently in combination following the administration of a spinal anesthesia. Ergova (1939) reported an incidence of 3.2 per cent for cranial nerve involvement in 128 cases. Forgue and Basset (1928) estimated the frequency to be up to 0.5 per cent. Thorsen found an incidence of 173 cases after 68,179 spinal anesthesias or 0.25 per cent from the combined reports of 46 published papers. The frequency in these papers varied up to 5 per cent. The usual trouble is a paresis of the oculomotor nerves, especially the abducens. This sixth nerve is affected in over 90 per cent of all cranial nerve paralyses following spinal anesthesia. It is unilateral in 75 per cent of the cases, the right nerve being more often involved than the left. The onset of symptoms usually occurs at the end of the first week but varies between the third and twenty-first postoperative days; it may be preceded by headache, nausea, dizziness, stiff neck, photophobia, and finally diplopia. Paralysis of the abducens nerve was first reported by Becker and Landow in 1906. By 1929, Blatt had collected over 100 cases; at the present time, over 500 cases have been reported. One-half of the cases improve within a month and almost every patient recovers spontaneously within a few weeks to a few months.

The anterior and posterior roots, the cord, as well as the peripheral nerves have been reported affected by spinal anesthesia. Clinical manifestations of irritation or impairment of the nervous structures are usually found as soon as anesthesia fades. At times, however, clinical symptoms are not present until days or weeks later. Then there may be motor weakness or paralysis with cord involvement. The paralysis is at first flaccid and later becomes spastic. Involvement of sensory fibers or tracts may be responsible for pain, paresthesia, or a varying degree of loss of sensation. Bladder and bowel dysfunction as well as disturbance of sexual function are not infrequent. Hasler (15) (1937) thought interference with the nervous mechanism of the bladder leading to urinary retention is the most common sequel of spinal anesthesia.

Lindemulder (1932) believed pain in the extremities, especially the legs, due to a radiculitis was a common sequel to spinal anesthesia and described 3 cases in which the pain with muscle tenderness persisted for several months. Brock and associates (1936) reported a syndrome of lumbar radiculitis beginning 3 weeks after operation. Jones (1932) had a case of sciatic pain lasting 6 months. Critchley had a case of a sacral radiculitis occurring 24 days after spinal anesthesia, and 2 cases of radiculomyelitis with evidence of more widespread involvement of the roots and spinal cord. Klein (1924) and Dassen (1931) described cases of myeloradiculitis. Hingson and associates (1943) reported 14 cases of decreased or painfully increased sensation of one or more nerve trunks. In most cases, pain cleared spontaneously but some received therapeutic nerve blocks with repeated novocain injections. Nicholson and Eversole (1946) described 3 cases of peroneal neuropathy. Loeser (1933) reported 5 cases of peripheral neuritis, occurring 1 to 3 weeks after intrathecal use of procaine, characterized by pain and paresthesia radiating along the course of the nerve and also involving motor fibers. This condition involved the ulnar nerve in 2 cases, radial nerve in 1 case, sciatic nerve in 1 case, and the lateral cutaneous nerves of the thigh in 1 case.

In 1937 Ferguson and Watkins reported 14 cases of cauda equina syndrome which almost immediately followed spinal anesthesia with heavy duracaine. They could find only 16 other similar cases in the literature. Characteristic of this syndrome were: (1) retention of urine occurring within 24 hours, lasting for 1 to 4 weeks and followed by incontinence for several weeks; (2) incontinence of feces with loss of anal sphincter tone (6 cases improved in less than 1 month; 3 cases improved in 3 months); (3) impairment of sensation in the buttocks and occasionally extending down the back of the thigh; (4) impairment of muscle strength in the lower extremities; and (5) alteration of the ankle jerk. Since this evaluation there have been additions. Critchley (1937) reported 8 cases, Yaskin and Alpers (1945) 2 cases, Aikenhead (1945) 3 cases, and there have been individual reports as well. White-Morguecho (1939) reported 19 cases of slight bladder paresis and of rectal incontinence in a series of over 3,000 cases. Pierson and Tomey (1940) described 1 case of neurogenic dysfunction of the bladder in a 60 year old man in which retention was relieved by presacral nerve resection after 2½ months. In some cases cystometric and cystoscopic studies were carried out after an interval of several months and revealed trabeculated hypertonic bladders with residual urine.

More extensive cord involvement following administration of spinal anesthesia has also been recorded. Devraigne, Suzor, and Laennec (1927) described a transient quadreplegia. Koster and Weintraub (1930), and Brock and associates (1936) mention cases of flaccid paraplegia occurring immediately after spinal anesthesia. Nonne and Denne (1928) reported a case of degenerative myelitis. Yaskin and Alpers (1945) had 1 case of primary lateral sclerosis syndrome with spastic crural paraparesis, and 1 case of incomplete thoracic transverse myelitis. Smith (1933) added a case of complete transverse myelitis occurring at the ninth thoracic segment on the seventeenth postoperative day. Ashworth (1933) mentions the case of a 51 year old man, who had an unsatisfactory spinal anesthetic with spinocaine, and sustained a complete paralysis of the cord below the ninth dorsal segment.

The incidence of death from spinal anesthesia has been variously reported as (a) 5 in 120,000 cases (2), (b) none in 250,895 cases (5), (c) 3 in 4,010 cases (54), (d) 2 in 5,150 (37). Foss and Schwalm (1933) and Lienhoop (1936) believed the mortality rate was no greater for spinal than for ether anesthesia.

CASE 1. D. K., a woman physician aged 29 years, was delivered on May 15, 1947 of a full term child. Because of a recently arrested tubercular infection, the delivery was accomplished by cesarean section under continuous spinal anesthesia. The anesthetic agent was 4½ per cent procaine and ¾ per cent ephedrine; a total of 130 milligrams of procaine was administered in 1½ hours. The anesthetic was introduced through the third lumbar interspace and a level of anesthesia up to the umbilicus was obtained. As the effect of the anesthetic cleared, the patient became aware of a low back pain radiating symmetrically into both sacroiliac regions and down the posterior aspects of the lower extremities to the ankles. The pain gradually eased but did not disappear during the next 5 days, at which time she

tried to stand and felt the same severe radiating pains down both legs. During the next few days the pain somewhat subsided so that on the ninth postoperative day she was able to get out of bed. At that time she further experienced an excruciating throbbing pain in the lower dorsal region which radiated upward into the head. This pain was completely relieved in the recumbent position, but was aggravated by sneezing. Subsequent attempts to reproduce this pain were unsuccessful. Four weeks after the operation, pain was slight and her only restriction on movement was an inability to bend forward.

Six weeks postoperatively she had a sudden exacerbation of pain on trying to rise from bed, and she continued to have excruciating pain during that week. In the seventh week she fell to the right when she tried to pick something from the floor, and was unable to arise except by leaning heavily on her left side. The following day she noted weakness in both lower extremities. During the next 10 days there was a rapid progression of symptoms. She became ataxic and felt "as though she was walking on cushions." She complained of formications of the skin of both legs and thighs. There was a numbness of the lower portion of the body which corresponded to a definite sensory level below the umbilicus for pin prick, temperature, and touch, as tested by the patient herself. Heel-to-knee ataxia was also marked. By the eleventh week there had developed numbness and stiffness in both ankles and feet; she was able then to walk very slowly with the help of a stick. During the fourteenth postoperative week, position and vibratory sense in both lower extremities was found to be absent.

A general physical examination on August 29, 1947 showed no significant abnormalities, except as later reported on the roentgenogram. There was no evidence of any new or active lesion in the lungs. Neurological examination showed a moderate weakness of both lower extremities but no muscle atrophy. There was marked heel-to-knee ataxia. Deep tendon reflexes were active throughout and equal in all extremities. The upper abdominal reflexes were markedly diminished. The lower abdominal reflexes were absent. Bilateral Babinski toe signs were present. The sensory examination showed a sensory defective level at the eleventh dorsal segment, and a zone of hyperesthesia at the first lumbar segment on the right.

Roentgenograms of the chest revealed linear densities in the upper portions of both lungs with some evidence of lateral traction of the mediastinal pleura along the cardiac contour. This was attributed to the old pneumothorax with a re-expansion of the lung. Roentgenograms of the vertebral column had no abnormalities. Lumbar punctures were unsuccessful on 4 separate occasions and a diagnosis of adhesive arachnoiditis secondary to spinal anesthesia was made.

At present this physician has paralysis in both legs. Her only improvement has been a slight return of sensation in patchy areas of both lower extremities. A course of x-ray therapy was given without benefit. Physiotherapy helped considerably by teaching her how best to use the remaining musculature.

Allergic history: The patient had a typical penicillin allergic reaction prior to her delivery. A rash developed over the area that was painted with merthiolate during her delivery. A skin test, for sensitivity to the anesthetic used, was carried out and was found to be negative.

CASE 2. P. P., a man aged 50 years, was admitted to Bellevue Hospital on May 3, 1949 with the chief complaint of numbness of both feet and nocturia. His past medical history revealed a gunshot wound in 1922. The bullet passed through the right ear and emerged from the left temporomandibular region. There occurred then an infection of the right mastoid bone which required a right mastoidectomy. As a result he has a right peripheral facial paralysis, loss of air conduction in the right ear, a hypesthesia on the right side of the pharynx, right palatal weakness, and a marked paresis of the left upper limb. He had an operation for a gastric ulcer in 1937 and a herniorrhaphy in 1944. Two years later he developed a recurrence of gastrointestinal symptoms and also noticed that he could no longer have erections or ejaculations. On January 9, 1949 he was readmitted to the same hospital for a subtotal gastrectomy. The operation was done under continuous spinal anesthesia with the usual strength of procaine crystals dissolved in cerebrospinal fluid and injected through the interspace between the third and fourth lumbar vertebrae. The patient remained in the hospital for 2 months before his discharge to a convalescent home.

At the time of his discharge he felt his legs were numb, but thought this was due to the long period in bed. He was in the convalescent home for a month and during that time found his legs were getting progressively weaker so that he had to use a cane for support.

General physical examination on admission to Bellevue Hospital was entirely within normal limits. On neurological examination he was found to have a broad based gait and a positive Romberg test. There was much weakness of flexion of both thighs on the abdomen and at the knee joints. Dorsiflexion of the feet was not weak. The deep tendon reflexes were overactive but equal. The plantar responses were flexor. The abdominal reflexes were equal and active. There was a level of reduced perception of pain at the groins; observers reported this level at the umbilicus bilaterally. Position and vibration sense were lost below the iliac crests.

Roentgenograms of the skull and vertebral column were normal. Eight attempts to obtain spinal fluid by lumbar puncture were unsuccessful. An unsuccessful traumatic cisternal puncture produced vomiting and headache. A laminectomy was performed between the twelfth thoracic and third lumbar vertebrae. The meninges and spinal cord were inspected. The pia-arachnoid was thickened, translucent, and firmly adherent to the dura. The spinal roots were

enmeshed in numerous fibrous adhesions. A small amount of fluid escaped at the first incision into the subarachnoid space. A fine rubber catheter could not be passed beyond 3 inches above and 2 inches below the operative area; no additional spinal fluid could be obtained. We believed there was a diffuse arachnoiditis up and down the spinal cord.

After the operation the patient was able to lift his legs off the bed. This was not possible before surgery. During the next few days, however, he had increased difficulty in voiding and this gradually developed into frequency and incontinence of urine. A transurethral prostatectomy was carried out to reduce the residual urine in the bladder. A repeat neurological examination a month later confirmed all the previous findings

Allergic history: No history of allergy was obtained. Skin test for the anesthetic used was negative.

CASE 3. R. R., a woman aged 23 years, was admitted to Bellevue Hospital in March 1948 for rehabilitation. This patient had been in good health before December 1946 when she had a cesarean section under continuous spinal anesthesia with procaine by the usual method of administration. In April, 1947 she noticed a numbness over her abdomen at the level of the umbilicus, and the onset of weakness in her right lower limb. During the next 2 months this weakness progressed and she became aware of additional weakness in the left lower limb. At the same time she noted a urinary disturbance which consisted first of urgency, and later incontinence of urine.

She was admitted to hospital for investigation of these complaints. A neurological examination then revealed her as having a waddling gait with bilateral foot drop, more marked on the right. There was marked weakness of both lower limbs, the right being more affected than the left. The deep tendon reflexes of the lower extremities were overactive and bilateral Babinski toe signs were present. A sensory reduction level was found below the tenth dorsal segment and overperception of pain between the seventh and tenth thoracic vertebrae. Position and vibration sense were not perceived below this level. Roentgenograms of the vertebral column were normal. A lumbar puncture was attempted but no spinal fluid could be withdrawn. Pantopaque was inserted into the cisterna magna and both roentgenograms and fluoroscopy showed a complete subarachnoid block at the level of the seventh thoracic vertebra. A laminectomy of the fifth, sixth, and seventh thoracic vertebrae revealed a markedly swollen and congested cord with an overlying adherent arachnoiditis. After the operation the patient developed a complete paraplegia with bladder and bowel incontinence.

Neurological examination on admission to Bellevue on March 23, 1948 verified the above neurological status. There was no thinning of the muscles of the lower limbs. The strength of the abdominal muscles was markedly decreased. There was anesthesia below the level of the seventh thoracic vertebra. The patient was given physiotherapy and rehabilitation exercises.

CASE 4. E. R., a man aged 63 years, was admitted to Bellevue Hospital on February 17, 1949 for rehabilitation. For the previous 8 years he was known to have a blood pressure of 180/100. For a period of 2 years he was slightly unsteady in his gait but had no impairment of sensation in the lower extremities. The Romberg test was negative. On January 15, 1948 a right hernioplasty for an incarcerated right hernia was done under spinal anesthesia. The anesthetic agent was 12 cubic centimeters of 1 in 1,500 nupercaine which was introduced in the interspace between the first and second lumbar vertebrae. Shortly after the spinal anesthetic was injected the patient became cyanotic and apneic for 1 to 2 minutes. The next day he had a left hemiplegia, weakness of the right lower extremity, incontinence of feces, and retention of urine. On the third day after the operation he was found to have a flaccid paresis of both lower extremities. Six weeks later, a suprapubic cystotomy was done because of repeated urinary infections.

General physical examination showed no abnormalities other than a blood pressure of 200/120. The vessels of the fundi showed moderate arteriosclerotic changes. The pupils were slightly irregular but reacted briskly to light and accommodation. There was slight increase in tone on passive movements of the left upper limb. There was moderate wasting and weakness of all muscle groups in the lower extremities, the left extremity being more affected than the right. Both limbs were spastic and were maintained in a position of mild flexion. The deep tendon reflexes were overactive in the upper limbs, the left side more than the right. The knee jerks were barely elicited; the ankle jerks were absent. Bilateral Babinski toe signs were present. Sensation was intact except for the absence of bladder and bowel sensation. A lumbar puncture revealed clear fluid under normal pressure. Manometrics indicated no block and spinal fluid chemistries were normal. A diagnosis of a cerebrovascular accident and spinal cord pathology secondary to spinal anesthesia was made. The patient was given physiotherapy and rehabilitation exercises.

CASE 5. J. S., a woman aged 26 years, was admitted to Bellevue Hospital on January 17, 1949 for rehabilitation. She was well until December 4, 1947 when she had had a cesarean operation under continuous spinal anesthesia. The spinal anesthetic used was 65 milligrams of procaine. It was introduced through "the third lumbar intervertebral space" and a level of anesthesia was obtained up to the umbilicus.

On the fourth or fifth postoperative day she complained of pain in the low back region at night and a feeling "like the banging of a hammer" over this area. Six weeks postoperatively she still complained of backache and also of numbness in both feet. Two weeks later, she walked "like drunk" and tripped

over her feet. Ten weeks after operation, there developed weakness at both knees and she fell when she tried to walk. She noticed the absence of painful sensation and position sense in her feet, and found she had bowel and bladder incontinence.

A laminectomy was performed on April 23, 1948 between the fifth and eighth thoracic vertebrae inclusive. The extradural fat and the dura were normal. The arachnoid was thickened and adherent to the cord producing a pocket of clear fluid at the site of the operation. The cord was thinned to about half its usual diameter and was displaced to the left.

A neurological examination on admission to Bellevue Hospital revealed slight wasting of both calf muscles. There was moderate weakness of both the extensors and flexors, the former being more affected, the muscles on the right more than those on the left. There was moderate weakness of dorsiflexion of both feet but the right side was definitely the weaker. The flexor muscles of both feet had good power. The knee jerks and ankle jerks were overactive, the right being more active than the left. On plantar stimulation there was an extensor response on the left but an equivocal response on the right. The superficial abdominal reflexes were present in the upper quadrants only. Position and vibratory senses were absent below the costal margin. Pain, touch, and temperature senses were impaired below the level of the tenth thoracic vertebra bilaterally with greater impairment for pain between the tenth thoracic and first lumbar segments on the right. A diagnosis of adhesive arachnoiditis secondary to spinal anesthesia was made. The patient was taught ambulation and elevation activities necessary for the maintenance of daily function.

CASE 6. R. G., a man aged 49 years, was admitted to Hospital on May 11, 1949 with umbilical pain. A diagnosis of incarcerated umbilical hernia was made and an emergency operation performed under spinal anesthesia. The anesthetic agent used was 120 milligrams of metycaine in a 10 per cent solution. It was diluted in 2 to 4 cubic centimeters of spinal fluid, and introduced between the third and fourth lumbar interspace. Anesthesia was obtained approximately to the level of the umbilicus. The only immediate postoperative complication was urinary retention, and the patient continued to have a residual urine until he was discharged from the hospital on May 17, 1949. Nine days later he returned to the same hospital because of increasing difficulty with micturition. Neurological examination on the following day showed normal deep tendon reflexes and a questionable sensory diminution over the first left sacral segment. A diagnosis of benign hypertrophy of the prostate and postspinal anesthetic atonia of the bladder was made. A transurethral resection was done on June 9, 1949.

A neurological examination 3 weeks after his readmission showed barely perceptible reflexes in the lower limbs with occasional fasciculations but no muscle wasting, and a suggestive level of diminished sensation at the eighth dorsal segment on the right. This sensory change was most marked over the first and second lumbar segments and over the pubic area. On lumbar puncture the spinal fluid was clear but contained 5 white cells per cubic millimeter. The initial pressure was 230 millimeters of water. The spinal fluid protein was 37 milligrams per cent. The Wassermann test was negative. The patient was discharged on July 6, 1949.

Shortly thereafter he was admitted to Bellevue Hospital with the chief complaints of inability to void, numbness in the perianal region, increasing constipation, and decrease in spontaneous erections. The urological service made the diagnosis of a neurogenic bladder with an enlarged median bar of the prostate, and a second transurethral resection was performed. Following this operation he was able to empty his bladder by the Credé method. He was then transferred to the neurological service for further evaluation of the neurological condition. On general physical examination there were no significant abnormalities. The blood pressure was 134/72. The rectal sphincter was normal. The prostate was not enlarged and no nodules were felt. On neurological examination, the positive signs were found confined to the lower trunk and extremities. The lower extremities were symmetrical with no evidence of muscular wasting or fasciculations. There was weakness of flexion of the left thigh on the abdomen and weakness of extension of the left leg on the thigh. No other muscle weakness was found. The heel-to-knee test was well done. The knee jerks were diminished bilaterally. The ankle jerks were absent. On plantar stimulation the response was flexor. There was diminished sensation to pin prick and light touch in the perianal region, and in an area extending forward over the perineum and genitalia. The same sensory diminution was found over the posteromedial aspects of both thighs to about 8 centimeters above the knees, and over the posterolateral aspects of both thighs and legs extending to the dorsum of the feet. This was more marked on the right side. Vibratory sense was decreased below the knees. Position sense was intact. Deep pain was felt.

The hematocrit and urinalysis were normal. The acid phosphatase was never above 1.7, the alkaline phosphatase 4.5. On lumbar puncture the spinal fluid was clear and colorless. It did not have cells and the pressure was 156 millimeters of water. The Wassermann test was negative. The colloidal gold was negative. The protein was within normal limits. A diagnosis of cauda equina syndrome secondary to spinal anesthesia was made. The patient was discharged to be followed in the clinic.

Allergic history: No allergic history was obtained. A skin sensitivity test for the anesthetic used was negative.

CASE 7. S. K., a woman aged 45 years, was admitted to Bellevue Hospital on May 4, 1948 with the chief complaint of inability to walk. Three weeks earlier on April 16 she had had a laparotomy under spinal anesthesia because of severe intermittent

lower abdominal pains with increasing abdominal distention. The anesthetic agent was 13.5 cubic centimeters of 1:1,500 nupercaine, and 1.5 cubic centimeters of 50 per cent solution of glucose. The postoperative diagnosis was a fibrous band constricting the proximal loop of ileum. Immediately following the operation she was found to have a flaccid paralysis with a total loss of sensation below the umbilicus.

On admission to Bellevue Hospital the general physical examination revealed no other abnormality than a prolapsed rectum. Neurological examination showed a congenital convergent strabismus. There was no cranial nerve involvement. The upper limbs were normal. There was a flaccid paralysis with urinary incontinence and constipation. The sensory examination showed a sensory defective level on the right side at the second lumbar vertebra with anesthesia below this segment. On the left side there was an area of diminished sensation from the tenth thoracic to the first lumbar vertebra with anesthesia below the first lumbar segment. On lumbar puncture the spinal fluid was clear with a pressure of 120 millimeters of water. There were no cells. The spinal fluid protein was 36 milligrams per cent and the Wassermann test was negative. Roentgenograms of the skull and vertebral column were normal. Re-examination 10 months later showed no significant change other than generalized wasting of the lower limb musculature, left greater than right, and severe shooting pains along the anterior and posterior aspects of the thighs. These pains had supervened some months earlier and were only partly relieved by a bilateral spinal chordotomy.

Allergic history: no allergic history was obtained. A skin sensitivity test for the anesthetic used was negative.

CASE 8. J. P., a pastor aged 51 years, was in good health until March 10, 1945 when he was operated upon for the removal of the gall bladder under spinal anesthesia. The anesthetic agent used was 18 milligrams of pontocaine with dextrose. It was introduced "into the third lumbar intervertebral space." A general anesthetic was later administered.

Immediately after the operation he was aware of numbness below the umbilicus and inability to move his lower limbs. Bladder and bowel control were lost; the patient became impotent and still is so. He was confined to bed for 5 months. In September 1945 he was permitted out of bed but required two crutches to get about. In February 1946, he had to undergo another operation for removal of stones from his bladder. On this occasion a general anesthetic was used with no additional postoperative sequelae.

The patient was re-examined on April 28, 1949. At this time he was able to walk, with help, for a short distance but with much difficulty. There were no abnormalities above the costal margin. The muscles of the left thigh were somewhat atrophic and there was marked weakness in flexing the left thigh on the abdomen. The left knee jerk was absent and the right knee jerk diminished. Both ankle jerks were equal and active. The plantar responses were both abnormal. The abdominal reflexes were absent. There was some diminution of sensation over the third left lumbar segment and over the skin area supplied by second sacral nerves; and a total loss of sensation over the third, fourth, and fifth sacral segments. Vibratory sense was lost below the iliac crests. There was bladder incontinence and constipation. The bulbocavernosus reflex was absent. A diagnosis of cauda equina or conus lesion, secondary to spinal anesthesia was made. The patient has been helped by rehabilitation but his neurological picture has remained essentially the same.

CASE 9. J. E., a man aged 25 years, was admitted to Bellevue Hospital on March 31, 1947 with the complaints of weakness and numbness of the right lower limb, incontinence, impotence, and a trophic ulcer on the sole of the right foot. This patient was in good health until June 1942 when he was admitted to an Army hospital for a left hernia and hydrocele operation. He received a spinal anesthetic.

Three days after the operation he noted frequency of urination and constipation. When he was allowed out of bed 18 days later, he noticed a right-sided limp. During the following weeks he was aware of weakness in the right lower limb and tingling sensations along the posterior aspect of this limb. He had an ache in the lower lumbar region which was aggravated by coughing and sneezing. He found that he was impotent. In November 1942, he was re-admitted for evaluation to an Army hospital for 3 months, but discharged with little change in symptoms.

Until July 1943 he performed limited duties as an administrative clerk, but was readmitted to hospital because of marked tingling and progressive weakness in the right lower limb, and the appearance of a prominent mass on the right buttock. He was discharged after 3 weeks of bed rest. In September 1943, he began to notice that he was wetting his bed at night. In December of that year he was again admitted to an Army hospital for a myelogram and an operation on the mass in his buttock. The latter was not removed but was diagnosed by biopsy as consisting of muscle, fat, fibrous tissue and dilated veins. The pantopaque myelogram showed a spotty distribution of the opaque substance in lumbosacral area. He was discharged to a Veteran's hospital with a 100 per cent disability pension in March 1944.

At the time of admission to Bellevue Hospital 3 years later, a general physical examination revealed a scar in the left inguinal region; a chronic ulcer at the outer aspect of the sole of the right foot; and, a soft flabby mass on the right buttock. Neurological examination was normal above the costal margin. He had slight muscle wasting in the right leg but could carry out a full range of motion with both lower limbs. There was, however, a weakness of the dorsiflexor and plantar flexor muscle groups on the right. Both knee jerks were sluggish. The left ankle jerk was also sluggish and the right ankle jerk was absent. The plantar responses were flexor. The

abdominal reflexes were present but diminished. Co-ordination was intact. There was an impairment to all forms of sensation below the eleventh dorsal segment on the right and the first lumbar segment on the left. A diagnosis of a lesion of the cauda equina and conus secondary to the spinal anesthesia was made. The mass in the right buttock was clearly telangiectatic, and caused a preoperative diagnosis of a pre-existing vascular anomaly of the lower spinal cord.

The patient had a laminectomy from the eleventh thoracic to the second lumbar vertebra under ether anesthesia on April 9, 1947. The dura was opened for its entire exposed length. Through the arachnoid a mass of varicose veins was seen. The arachnoid was then incised and a dense mass of varicose veins was seen at the upper end of the exposed cord. Further investigation revealed a large mass of blood vessels on the right side under overhanging edges of the lateral portion on the right lamina of the first lumbar vertebra. A small green mass was observed on the right side anteriorly. A small piece of this was removed by careful dissection. On microscopic examination it was found to consist of fibrous tissue in which were embedded large clumps of yellowish-brown pigment. This gave the positive Prussian blue reaction for hemosiderosis. Vessels were dissected free from the roots and were coagulated with a mild current. During the dissection two of the vessels ruptured, but the bleeding was controlled. Coagulation of some of the vessels decreased their bulk considerably. The wound was then closed.

Convalescence was prolonged and complicated by repeated urinary tract infections. At the time of discharge from hospital in August 1947, there had been no improvement in muscle strength. There was a slight reduction of the sensory impairment in the left lower limb. Bladder control was unchanged. Bowel sensation was lost and large protruding internal hemorrhoids formed. He continues to be impotent. The ulcer on the foot persists.

CASE 10. A. M., a man aged 61 years, had an abdominal-perineal resection and a coccygectomy for adenocarcinoma of the rectum; 760 milligrams of 3.3 per cent novocain was administered as a continuous spinal anesthesia. He remained in the hospital for 2 months following this operation.

At the time of discharge he was able to walk but with much difficulty because of pain and paresthesia in both lower extremities. He had reported numbness and tingling in both legs below the knees, especially on the right, since recovery from the anesthesia. Ten weeks after operation, he noted a progressive weakness of his lower limbs and involuntary flexor spasms of the right hip and knee joints. The lower extremities were cold, stiff, and sore. On neurological examination then there was atrophy of symmetrical muscle groups in the lower limbs and a diminution of muscle strength with poor co-ordination. He had a spastic "scissors gait." The deep tendon reflexes of the lower extremities were overactive but equal. There was a left Babinski toe sign. The superficial abdominal and cremasteric reflexes were absent. There was decreased perception of pain below the sixth dorsal segment bilaterally. Vibration and position sense were impaired in both lower limbs. Light touch sense was intact. Lumbar puncture revealed clear, colorless fluid under initial pressure of 50 millimeters of water, but with a definite manometric block. A second lumbar puncture later failed to obtain any fluid. Arthritic changes were seen on the roentgenograms of the dorsal spine. There was no evidence of any metastatic lesion. Other laboratory data were within normal limits. The sedimentation rate was not elevated. The patient was discharged from the hospital without any improvement 5 months after the operation.

CASE 11. M. P., a woman aged 39 years, was admitted to Bellevue Hospital on September 12, 1949, with a 5 week history of pain which radiated down the posterior aspect of the right lower limb to the ankle, and was increased by coughing and sneezing or other straining. In addition, there was a more recent feeling of numbness in the toes of this foot. She had a history of a similar pain in the left lower limb in 1937. It disappeared after 6 weeks of rest in bed except for a feeling of stiffness and aching in the lower back when she bent down or moved heavy objects. In 1947 she first noted the pain in the right lower limb but it improved after a period of 2 weeks' rest in bed, leaving a residual aching in the low back area.

The general physical examination did not reveal any abnormality. The anal sphincter tone was good. Blood pressure 152/90. The neurological examination was normal above the costal margin with overactive reflexes in the upper limbs. The patient was in pain with every movement of her body, particularly those involving her back and lower limbs. There was a marked list to the left with the pelvis tilted higher on the right side. Walking was slow and difficult due to pain. There was a marked spasm of the paravertebral muscles of the low back, especially on the right side with a loss of the normal lumbar lordosis. A right lumbar scoliosis was present. There was no wasting of any muscle groups but a definite weakness of dorsiflexion of the left foot was noted. The power of the other muscles was difficult to evaluate because of the pain on movement. There was a bilateral Lasègue sign. The knee jerks were overactive but equal. The ankle jerks were absent. The plantar responses were flexor bilaterally. Sensation was intact except for a possibly diminished touch sensation on the dorsolateral side of the right foot.

Complete blood count and hemogram were normal. A lumbar puncture revealed clear spinal fluid under normal pressure. It contained 1 lymphocyte. The spinal fluid protein was 72 milligrams per cent. The Wassermann and colloidal gold curve were normal. A pantopaque myelogram demonstrated an almost complete subarachnoid block at the fourth lumbar interspace.

On September 27 an interlaminar exploration was done at this level. At the request of the anesthetist consent was given for spinal anesthesia for this operation. The anesthetic agent was a mixture of about 5 per cent pontocaine, glucose, and neosynephrine. The period of anesthesia lasted 1 hour and 55 minutes. The blood pressure fell immediately to a low level but responded to ephedrine. Later it became low again and 1 milligram of neosynephrine was given intravenously to return the blood pressure to a normal level.

On exposure, a large protruding nucleus pulposus was found at the fourth lumbar interspace and was seen to be exerting pressure on the roots bilaterally, but more on the right side. This herniated disc was removed extradurally and the wound closed. There were no known complications till the third postoperative day when she complained of difficulty in voiding and was found to have a patchy sensory loss in the lower limbs. On the fourth day, both gluteal muscles were found to be weak. The anal sphincter tone was markedly reduced. There was impaired sensation about the anus and diminished sensory perception on the lateral aspects of the sole of the right foot. On the thirteenth postoperative day she was still unable to void spontaneously and had an increasing weakness of the right lower limb with resultant difficulty in walking. The sensory changes persisted. On the nineteenth postoperative day, there was marked weakness of the left lower limb particularly of dorsiflexion of the left foot. There was definite diminution of sensation over the right sacral segments and a small patch of impaired pain sensation in the perianal region of the left buttock. There was also a sensory diminution to pain and touch over the dorsolateral surfaces and soles of both feet. The patient was constipated and had no rectal sensation. She was discharged unimproved.

CASE 12. Personal communication by courtesy of Doctor Frederick A. Fender, San Francisco: "A partial gastrectomy (under spinal anesthesia) was carried out on a 50 year old otherwise healthy man, for the treatment of ulcer, in April of 1949. Ten weeks after his operation there was a 10 day episode of pain in the midline back with coughing and sneezing. A few days after this pain disappeared, the patient noticed difficulty in walking and balancing. To make a long story short, the condition progressed to paraplegia. The striking thing about this case is that the appearance of the cord, at laminectomy, was exactly like the cord you have described: strangulating arachnoiditis."

COMMENT

The neurological complications of spinal anesthesia occur in those regions of the central nervous system or its membranes most closely situated to the site of injection of the anesthetic compound. This is attested by the reported cases, together with operative and postoperative observation. These sequelae are rarely due to direct injury since such accidents are not found after lumbar puncture. In rare cases, marked symptoms occur in patients who complain of severe pain during the injection of the anesthetic; intramedullary hemorrhage has been reported (32, 71) in a fatal case of spinal anesthesia. On introduction of the effective agent into the subarachnoid space dilution and diffusion occur, but not before considerable absorption and fixation have taken place near the site of injection where the membrane and nerves are in contact with the full concentration of the anesthetic drug. This is important when correlated with the experimental work of Lundy, Essex, and Kernohan who reported, "the concentration of the drug is as important as the total dose so far as permanent effects are concerned."

Macdonald and Watkins have shown the concentration of the necessary annectent chemical substances in the anesthetic solution other than the anesthetic drug cannot produce paralysis. Moreover, experimental evidence has demonstrated that the anesthetic substance *does* have a myelolytic effect on the cord, most marked caudally and that "the posterior aspect and the periphery of the cord seem to be principally involved" (33).

In a large proportion of cases in the literature the site of injection has been at the level of the conus medullaris or even the lumbar enlargement of the spinal cord. Arnheim and Mage, in a study of 68 cases, found that in 27 cases injection was above and in 41 cases below the second lumbar vertebra. Newell states, "Spinal puncture can be made for the purpose of introducing an anesthetic agent anywhere from the fourth lumbar interspace up into the thoracic region!" His sole objection to administration at the higher levels is the increased possibility of "respiratory or circulatory collapse." Therefore, he recommends that the injection be made at the first lumbar interspace for upper abdominal operations, second lumbar interspace for lower abdominal operations, and third lumbar interspace for surgery of the perineum or extremities.

The contraindication to the use of spinal anesthesia in pre-existing disease of the central nervous system has already been dis-

cussed. Lundy and associates (53), however, go most absurdly and fallaciously far, writing, "Judging from our experiments, it seems probable that when paralysis follows the use of ordinary doses of spinal anesthetic agent, the spinal cord was previously diseased." Critchley reported 1 case of multiple sclerosis, 1 of progressive muscular atrophy, and another of neurosyphilis with the suggestion that spinal anesthesia may have been the precipitating agent of these diseases. Additional literature is available in which there has been reported an acute onset or exacerbation of central nervous system syphilis after spinal anesthesia (25, 69). Ericsson reported a case of paraplegia occurring immediately after spinal anesthesia for abdominal surgery in a 68 year old man who had a history of temporary paraplegia at the age of 20. The postmortem diagnosis 1 month later was "hemorrhage into the spinal cord."

Wyburn-Mason found that venous angiomas of the cord occur in 3 to 4 per cent of cases of laminectomy. Kaydi (1889) made a detailed study of the veins of the spinal cord and found that dilatations and tortuosities of these vessels were not uncommon, particularly on the posterior aspect of the cord. Case 9 of our series was seen to have marked varicosities of the spinal cord at the time of laminectomy. We do not doubt that these had been present before the administration of the anesthetic. However, this patient had had no complaints and had been on full active duty in the Army of the United States until the time of his herniorrhaphy. The paralysis, sensory loss, bladder and bowel incontinence, and impotence were caused by giving a spinal anesthetic. These palsies could not have been brought on by the use of any other form of anesthesia.

Federighi has commented on the increased sensitivity to spinal anesthesia in pregnancy, and notes that several deaths have been recorded after intrathecal injection of small doses of anesthetic preparations. Two cases of death within 45 seconds, after intrathecal injections of 2 cubic centimeters of amylocaine are reported by Walker and Matthews. After death of the mothers, successful cesarean sections were carried out. Bourne and Williams in 1948 record their opinion based on their experience in Queen Charlotte's Lying-in-Hospital and St. Mary's, London: "There is, we fear in this country a considerable number of young healthy pregnant women who stand condemned to death by spinal anaesthesia for Caesarean Section." Three of our patients sustained their symptoms as the result of spinal anesthesia for a cesarean operation.

A cautious approach has also been advised in elderly hypertensive patients with arteriosclerotic vessels, because of the possibility of the rapid and marked lowering of blood pressure in spinal anesthesia.

We do not question the advantages of the excellent and admirable relaxation of the abdominal musculature produced by spinal anesthesia. On the other hand, one cannot underestimate the gravity of the many possible complications nor the probability of their permanence; nor can we overlook the fact that often spinal anesthesia has to be supplemented by general anesthesia.

Spinal anesthesia has many dangers, far too little appreciated by surgeons and anesthetists.

SUMMARY

In summary, we have attempted to review the literature of this subject. We have reported 12 cases of grave paralyses following the use of spinal anesthesia; these in addition to 3 other cases published by one of us in 1945 (44). It is to be noticed that throughout the literature there is a huge variation in the figures given of complicating nervous system symptoms. An explanation for such lack of uniformity in figures may very well be found in the fact that often and in the majority of our cases spinal cord symptoms appeared some considerable time after the patient had been discharged from surgical care, so that the surgeon and anesthetist and, indeed, occasionally the patient were unaware of the relationship of the progressive paralysis of the legs to the previous spinal anesthetic.

So, spinal anesthesia is accompanied by many definite and terrible dangers which are far too little appreciated by surgeons and anesthetists.

From a neurological point of view, we give the opinion that spinal anesthesia should be

rigidly reserved for those patients unable to accept a local or general anesthetic.

Paralysis below the waist is too large a price for a patient to pay in order that the surgeon should have a fine relaxed field of operation.

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PROLONGATION OF OCCLUSION OF THE CAVAE IN DOGS BY DIVERSION OF THE CIRCULATION

I. Cannulation of the Superior Vena Cava

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THE problem of by-passing the blood from the heart requires solution in order to permit deliberate operations on the valves and septa in a relatively bloodless area. Gibbon and Bjork have described elaborate apparatus and interesting results in this field, although the heart had not yet been successfully opened widely and operations on its interior carried out. Much of the apparatus devised by these workers has been devoted to aeration of the blood. In order to deprive the *left* side of the heart of blood for operations on the mitral valve, for example, this is a necessity. However, for operations on the *right* side, in which the tricuspid or pulmonary valves or the septa may be attacked, it may not be necessary to oxygenate the blood extracorporeally. If this is so, a most complicated procedure would thus be eliminated.

In our experiments, the animal's own lungs were used for the oxygenation of the blood rather than a mechanical apparatus.

At the outset of the present experiments an attempt was made both to divert the flow of blood and to open the right auricle. This was later simplified, and the experiments are merely designed to occlude the cavae and divert the flow of blood from the right side of the heart, oxygenate it by passing it through the animal's own lungs, and return it to the left side of the heart which can then pump it through the coronary, cerebral, and peripheral vessels. While the cavae are occluded, the only blood entering the right side of the heart is the coronary venous flow. The purpose of the experiments was to determine whether occlusion of the cavae could be prolonged by this method.

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METHOD

Large dogs fed on kennel rations supplemented with meat were used. Food was withheld for 24 hours before any procedure was performed. Quinidine (0.4 gm.) was given orally 2 hours prior to the beginning of the operation. The operations were performed under sodium pentobarbital anesthesia administered intravenously, with air given intratracheally under positive pressure. The right side of the chest was opened in the fourth intercostal space. A cannula was first placed in the branch of the right pulmonary artery to the right upper lobe directed toward the heart (Fig. 1). To this cannula was attached the rubber tubing which carried the blood from the pump. A right angle cannula was passed through the azygos vein and superior vena cava pointing cephalad. Ligatures around the vessels held the cannula in place and prevented blood from leaking around it. The azygos vein was ligated distally to the opening in it. The tubing attached to the cannula in the superior vena cava carried blood to the reservoir bottle into which, in some of the experiments, two to three hundred cubic centimeters of blood from a donor animal were placed. Later normal saline solution was tried and found to be satisfactory to prime the pump. Just before inserting the cannula into the superior vena cava, an accurately measured dosage of heparin (0.25 to 0.30 mgm. per kgm. of body weight) was given intravenously with a tuberculin Luer syringe. The pump was then started as blood began to flow into the reservoir bottle. The inferior vena cava was next occluded with a clamp just inferior to the right auricle.

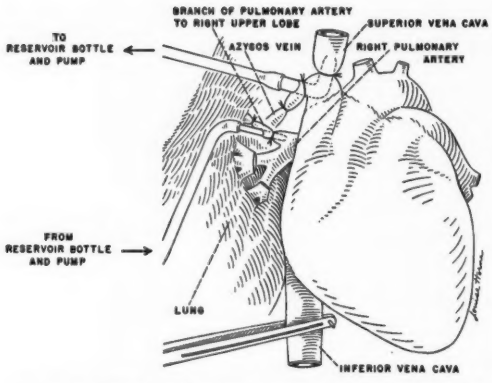

Fig. 1. Drawing showing cannulation of the superior vena cava and the branch of the right pulmonary artery to the upper lobe. A clamp occludes the inferior vena cava.

The "total flow" of blood passing through the pump was determined by multiplying the number of revolutions of the pump by the output in cubic centimeters per revolution. The "average flow" in cubic centimeters per minute was calculated by dividing the "total flow" by the number of minutes the pump was in operation.

After the period of occlusion of the cavae the clamp was removed from the inferior vena cava; then the cannula was removed from the superior vena cava, and the azygos vein ligated proximally to the opening in it. Five cubic centimeters of a 1 per cent solution of protamine were given intravenously to neutralize the heparin in all animals who survived. The lung was expanded and the wound closed in layers.

In another group of animals the chest was opened in a similar manner and the cavae occluded for varying periods of time after first ligating the azygos vein. The clamps were removed in some experiments when the heart rate became slow or the pulsations weak. In others, the clamps were left in place for a prolonged period in spite of the apparent difficulty in beating that the heart manifested.

After the cavae were released, in both groups of experiments, it was necessary in some cases to attempt revival of the heart by means of analeptics, cardiac massage, and electrical shocks for defibrillation. Electrocardiographic tracings were obtained in 3 of the experiments.

RESULTS

Thirty experiments were performed on 24 dogs. In 4 preliminary experiments an attempt was made to open the right auricle during the diversion of the blood. These animals received large doses of heparin and hemorrhage played a considerable role in their death.

Eight dogs survived occlusion of the cavae for from 7½ to 17 minutes when the pump was employed to divert the blood stream (Table I). The superior vena cava was occluded from 2 to 8 minutes longer than the inferior vena cava, but the period of occlusion of the latter is considered to be the "effective" period of occlusion if an open operation on the right side of the heart is to be performed.

Five of the 8 dogs which survived the occlusion of the cavae were observed from 23 days to over 1 year and either are still living or died from some cause unrelated to these experiments. Following experiment 8 the occlusion was repeated after an interval of 9 minutes, during which time blood was allowed to flow through both cavae. The animal succumbed following the second period of occlusion (Table I, Experiment 9).

Two of the animals survived only 48 hours. These 2 had the longest periods of occlusion (16 and 17 minutes). The cause of death of the first one was not determined. The second animal apparently died with pulmonary edema.

In 5 of the 13 experiments the animal did not survive occlusion of the cavae (Table I). Cardiac arrest occurred in 1 just as the pump was started. Pulsations of the heart became weak in another and, although fibrillation did not supervene, the heart finally stopped after attempts at resuscitation for 32 minutes. Ventricular fibrillation occurred in the remaining 3 animals 4, 8, and 10 minutes following release of the cavae. The heart dilated prior to removal of the caval obstruction in 2 of the 3. In all of these, attempts at resuscitation were made, cardiac massage and analeptics being used, and in some cases defibrillating electric shocks. Recovery followed revival of the heart in experiment 11 (Table I), but the animal died 48 hours later. In this case car-

TABLE I.—OCCLUSION OF CAVAE WITH DIVERSION OF THE BLOOD

Expmt. No.	Weight —kgm.	Quinidine—gm.	Heparin —mgm.	Period of occlusion—min.		Amount of blood delivered by pump			Protamine—c.c. of 1% solution	Remarks
				SVC	IVC	Total flow	Duration —min.	Average flow—c.c. per min.		
1	20		5	12	7		13		5	Recovered. Alive over 1 year. No quinidine
2	16		4	11	7		12		5	Recovered. Sacrificed after 28 days. No quinidine
3	11		3	6	1				5	Died. Heart beat became feeble suddenly, followed by fibrillation 4 min. after cavae released. No quinidine
4	11	0.4	3.5	18	15½	3.0 (approx.)	19	160 (approx.)	5	Recovered. Sacrificed after 23 days
5	24		6							Died. Cardiac arrest as soon as pump started. No quinidine
6	16	0.4	4	23	15	6.4	24	267	5	Recovered. Sacrificed 49 days later
7	27	0.4	6.75	17½	16	5.26	18	292		Died. Heart dilated before cavae released. Cardiac arrest, massage, adrenaline, novocain. Fibrillation followed 10 min. after cavae released
8	16	0.4	4	8	7½					Recovered. A second period of occlusion followed a 9 min. interval (experiment 9)
9	16	0.4	4	10	8½					Died. Cardiac arrest was followed by regular but weak pulsations; analeptics, massage. Heart stopped after 32 min. No fibrillation
10	13	0.4	3.2	17	15	2.3	17	135	5	Recovered. In good condition 6 months later
11	17	0.4	6	19½	16	4.4	20	220	5	Recovered. Died 48 hours after experiment. No autopsy
12	17	0.4	4.5	9½	9	2.46	10	246		Died. Heart beat became slow, heart dilated, cavae released, adrenaline, massage, caffeine; fibrillation 8 min. after I.V.C. released
13	20	0.4	5	20½	17	3.3	21	157	5	Recovered. Died after 48 hours. Pulmonary edema present

diac massage, with 1 cubic centimeter of epinephrine (1:1000) injected into the right ventricle, established a normal beat. The heart rate had become very slow, with weak contractions, and had dilated immediately following release of the cavae. In no case could the heart be revived after fibrillation supervened. This usually did not develop until the heart rate had first become slow, with weak pulsations, or had become dilated following release of the occluded cavae.

The flow of blood through the pump was determined in 7 experiments. In one instance this was only an approximation made from several determinations of the rate of the pump. The average flow varied from 135 to 292 cubic centimeters per minute (average 211). The pump was in action from 10 to 24 minutes.

Thirteen control experiments were performed on 8 animals to determine how long the cavae could be occluded with survival, without diversion of the circulation (Table II). Death occurred in 6 instances, the cavae being occluded from 7½ to 33 minutes. Ventricular fibrillation was present in every fatality. An electrocardiographic tracing was obtained in one of this group which illustrates the course of events which terminated in ventricular fibrillation (Fig. 2). Following the remaining 7 of the control experiments in which the clamps were removed as soon as the pulsations became weak or the pulse became slow, the animal recovered. The heart was seen to dilate temporarily, following removal of the clamps. The periods of occlusion of the cavae followed by recovery were from 1 to 9 minutes with an average period of 4 minutes.

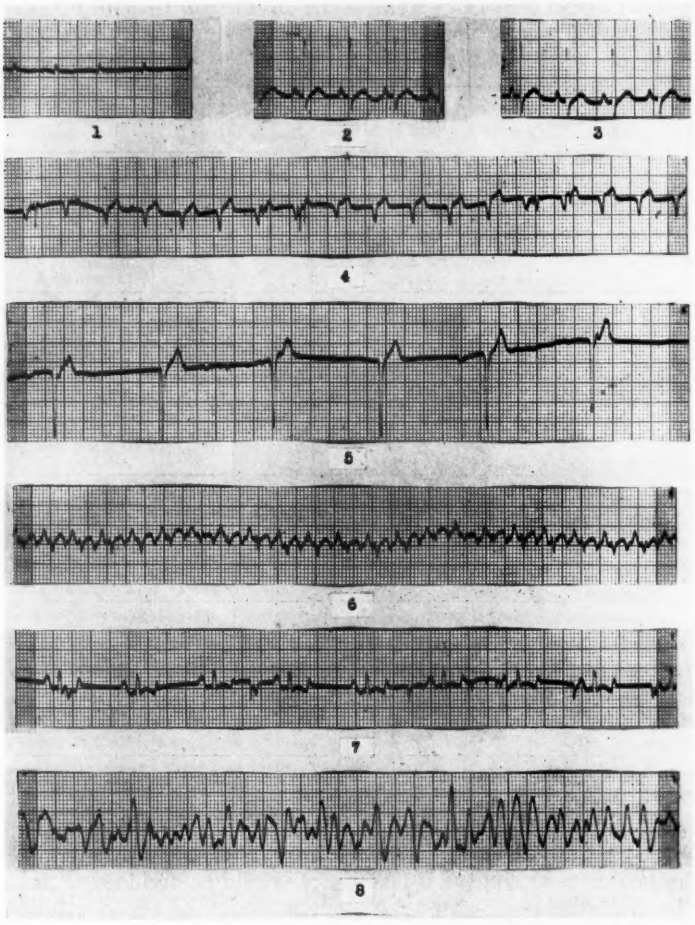

Fig. 2. Electrocardiograms taken serially in experiment 7, Table II. 1, 2, 3, Controls (Leads I, II, and III). The remaining records are Lead II. 4, Electrocardiogram taken 1 minute after clamps were applied to cavae. Idioventricular rhythm. 5, Two minutes after cavae were occluded, nodal rhythm. 6, The cavae were released for 5 minutes and then reclamped. This record was taken 1 minute later. Auricular tachycardia. 7, Eleven minutes after second clamping of the cavae. Sinus rhythm with ventricular extra systoles from different foci and auriculoventricular blocks. 8, The cavae were occluded 14 minutes after reclamping and then released. This record was taken 3½ minutes after the cavae were released. Ventricular fibrillation.

DISCUSSION

The period of time that the cavae may be occluded may be extended by shunting blood from the superior vena cava to the pulmonary artery by means of a pump. It is obvious from the values of the average flow in cubic centimeters per minute given in Table I that the amount of blood shunted is small compared to the normal cardiac output of dogs of comparable size. This value is also small when compared to the fraction of the cardiac output which flows to the anterior extremities and head and is drained by the superior vena cava. Levy and Blalock partitioned the cardiac out-

TABLE II.—OCCLUSION OF CAVAE WITHOUT DIVERSION OF THE BLOOD

Experiment No.	Weight—kgm.	Quinidine—gm.	Period of occlusion (min.) SVC	Period of occlusion (min.) IVC	Remarks
1	19	0.4	33	33	Died. Onset of fibrillation 11 min. after occluding cavae. Pulse dropped from 136 to 42 in 21 min.; then to 12 in 31 min. Rhythm irregular preceding fibrillation
2	14.5		6½	7½	Died. Heart became slow and weak. 1½ min. after cavae released, rhythm of auricles and ventricles became dissociated. Electric shock unsuccessful; fibrillation not reversed. No quinidine
3	14	0.4	14½	15	Died. Pulse dropped from 132 to 80 in 13 min.; pulse weak. Heart dilated after cavae released. Fibrillation
4	10	0.4	4 9 5	4 9 5	Recovered. Heart resumed normal rate and rhythm after each period of occlusion. Dog sacrificed after observation of heart for 9 min. after 3rd period of occlusion
5	12	0.4	1 2	1 2	Recovered. Heart appeared to be stopping after 1st period of occlusion; again, after second period of occlusion. Dog died 3 days later from unrelated cause
6	13	0.4	10½	10½	Died. Pulse fell from 136 to 84 in 2 min.; then rose to 188 in 1 min.; then fell to 80 in 7 min. Heart dilated after release of cavae. Fibrillation 6½ min. after release
7	14		3½ 14	3½ 14	Recovered from 1st period of occlusion. Pulse became rapid, then normal. Second period of occlusion 5 min. after 1st. Died after 2nd period of occlusion. Pulse fell from 132 to 56; then rose to 112; then dropped to 76 all in 5½ min. Massage, analeptics, electric shock failed to reverse fibrillation. No quinidine. Electrocardiogram obtained
8	12		3½ 9	3½ 9	Recovered from 1st period of occlusion. Pulse rose from 160 before occlusion to 204 one min. 15 seconds after occlusion. Died 15 min. after release of cavae after 2nd occlusion. Pulse became slow and weak; fibrillation. No quinidine

put in dogs and found that an average of 31.3 per cent of the cardiac output supplies the anterior extremities and head. The average weight of the 7 dogs in which average flows were determined was 17 kilograms; therefore, the average cardiac output may be assumed to be about 2,500 cubic centimeters per minute. Since the average of the flows is 211 cubic centimeters per minute, this represents only about 8 per cent of the estimated cardiac output. The low output of the left side of the heart during the period of occlusion of the cavae may produce central changes which influence the survival of the animal or may reduce the coronary flow to a point where failure of the heart or fibrillation supervenes.

Quinidine appears to be of some value in preventing fibrillation in the small number of cases in which it has been used. The action of heparin was completely arrested by the administration of protamine. The former was given in close to the minimal dosage required (3 to 6 mgm.) and the latter was given in a relatively large dose (5 c.c. of a 1% solution) without any noticeable adverse effects. For these short experiments the type of pump described by Beck in 1926, in which rollers pass over a rubber tube, appeared to be satisfactory and seemingly played no part in the mortality.

Templeton and Gibbon have been able to occlude the cavae for as long as 9 minutes without shunting the blood and have reported operations on the tricuspid valve in a relatively bloodless field. In some of the experiments described here, this period of time was extended.

SUMMARY

1. A method for diversion of the circulation from the superior vena cava to a pump and thence through the pulmonary artery to the left side of the heart is described. The inferior vena cava is occluded during the experiments. This should make the right side of the heart relatively bloodless, except for the coronary venous flow.

2. Heparin was used in small doses and was neutralized satisfactorily at the end of the experiment with protamine.

3. A control group of experiments is reported in which occlusion of both cavae was done without diversion of the circulation.

4. In both groups of cases, when death occurred, it was almost always following a train of events culminating in ventricular fibrillation.

5. The length of time that occlusion of the cavae can be maintained is extended by diversion of the circulation.

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THE SOLITARY GALLSTONE

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SOLITARY gallstones are often interpreted as harmless occupants of the gall bladder and when found during the course of routine health examinations are apt to be dismissed as unimportant findings if they are not producing symptoms. The purpose of this paper is to demonstrate that the solitary stone produces the same signs and symptoms as those caused by multiple stones, that it causes the same complications, and that these occur with sufficient frequency to make its presence, even when asymptomatic, a positive indication for cholecystectomy.

A review of the literature for the last 20 years fails to reveal any articles dealing primarily with the solitary stone. There are isolated case reports of intestinal obstruction due to solitary stones but only two articles which bear even remotely on the problem. One of these is a report by Blain and Harkins of 41 cases of intestinal obstruction due to gallstones, collected from the files of the Johns Hopkins Hospital from 1889 to 1945. In 8 of these the obstruction was produced by a solitary stone while in 2 there was an associated carcinoma of the gall bladder. The other report concerns the relative incidence of solitary stones as compared with multiple stones (3). Truesdell examined the gall bladders of 500 patients who had celiotomies performed for operations on lesions other than those of the biliary tract. Gallstones were found in 50 cases. Of these, 11 were reported to be solitary stones, an incidence of 22 per cent.

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The material for this paper was obtained from the records of a series of 387 consecutive cases of patients operated on at the Presbyterian and Woman's Hospitals with a final diagnosis of cholelithiasis. Solitary gallstones were found in 82 of these cases, an incidence of 21 per cent. On the basis of gross inspection they were classified as cholesterol stones in 58 cases and mixed stones in 24. They varied in size from 0.7 to 7.0 centimeters in greatest diameter, only 2 measuring less than 1 centimeter. A study of their incidence according to sex showed them to occur with slightly greater frequency in the male. Their distribution according to age was essentially the same as that encountered for multiple stones (Table I).

A comparison of the frequency of the signs and symptoms produced by solitary and multiple stones revealed little information of significance. A history of abdominal pain was the outstanding symptom in the majority of the cases in both groups while nausea, vomiting, and dyspepsia were reported frequently. A history of chills and fever was obtained in

TABLE I.—INCIDENCE AND DISTRIBUTION OF MULTIPLE AND SOLITARY GALLSTONES IN 387 CASES

	No. of multiple	No. of solitary	Per cent solitary
Female	249	62	19.03
Male	56	20	26.31
Total cases	305	82	21.18
Age distribution, years	16–81	25–74	

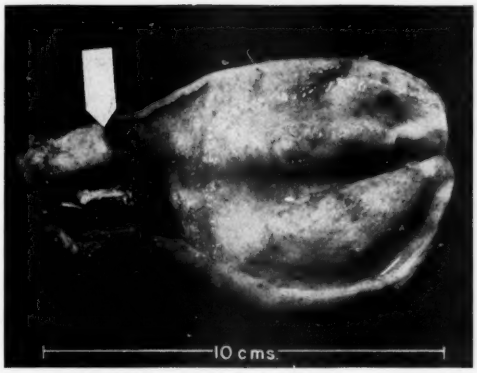

Fig. 1. Solitary stone impacted in the ampulla of the gall bladder producing a hydrops. Arrow points to orifice of cystic duct.

approximately 10 per cent of the patients with solitary stone as compared with 3 per cent for the patients with multiple stones. Local tenderness was by far the most frequent finding on physical examination in both groups. A palpable mass or jaundice occurred with about equal frequency. The indications for surgery in the majority of the 387 cases studied were for symptoms referable to the biliary tract. In 10 cases of multiple stones cholecystectomy was performed in the absence of symptoms, the sole indication for operation being the cholecystographic demonstration of their presence. The indications for surgery in the presence of solitary stones were more rigid, symptoms referable to the biliary tract being present in each of the 82 cases.

Some of the patients who had solitary stones had known of their presence for varying periods of time before onset of the symptoms which led to their removal. A typical example was a patient who first consulted her physician because of a vague type of backache for which orthopedic measures were instituted. A solitary gallstone which was found during the course of the examination was thought to be an incidental finding and the patient was told that nothing need be done about it. Approxi-

TABLE II.—COMPARISON OF FREQUENCY OF SYMPTOMS

Symptoms	305 cases of multiple stones		82 cases of solitary stones	
	No.	Per cent	No.	Per cent
Abdominal pain	253	82.95	75	91.46
Nausea	165	54.09	34	41.46
Vomiting	183	60.00	32	39.02
Dyspepsia	78	25.57	45	54.88
Chills and fever	9	2.95	8	9.75
No symptoms	10	3.28	0	0

Fig. 2. Cholecystogram reported as showing presence of a solitary stone.

Fig. 3. Photograph of specimen after removal revealing multiple stones.

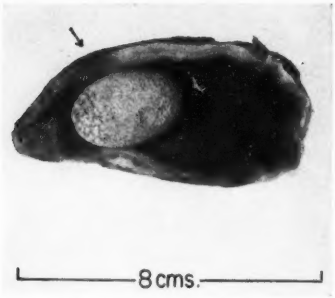

Fig. 4. Acute cholecystitis with local area of gangrene at site of impaction of a solitary stone in neck of gall bladder.

mately a year later she had a typical attack of biliary colic followed by the appearance of a tender mass in the right upper abdominal quadrant consistent with a distended gall bladder. At operation she was found to have a hydrops of the gall bladder due to the impaction of a large solitary stone in the ampulla. Cholecystectomy relieved her of all of her symptoms including the backache (Fig. 1).

The only way a diagnosis of solitary gallstone can be made prior to operation is by cholecystography. Roentgenologists readily admit that such a diagnosis is subject to error and that multiple stones may be present when a solitary shadow is seen on the cholecystogram. This error occurred in 19 out of 51 instances in which an x-ray diagnosis of solitary stone was made in this series, an error of 37.25 per cent (Figs. 2 and 3). The x-ray report of multiple stones was much more accurate although there were 7 instances out of 139 such reports in which a solitary stone was found at operation. It is evident that while a report of gallstones approaches 100 per cent in accuracy, any attempt to predict the actual number present is unreliable.

The complications of chronic cholecystitis with cholelithiasis are well known and may be classified as acute cholecystitis, hydrops, empyema, gangrene with or without perforation, obstruction of the common bile duct, acute pancreatitis, internal biliary fistula, and carcinoma of the gall bladder. A comparison of the frequency of complications produced by solitary stones with those produced by multiple stones revealed a significant difference,

TABLE III.—COMPARISON OF FREQUENCY OF SIGNS

Signs	305 cases of multiple stones		82 cases of solitary stones	
	No.	Per cent	No.	Per cent
Tenderness	275	90.16	64	78.04
Palpable mass	28	9.18	13	15.85
Jaundice	29	9.50	7	8.53
No signs	15	4.91	0	0

one or more of the above complications being present in 41.47 per cent of the patients with solitary stones as compared with 29.84 per cent of the patients with multiple stones. As shown in Table V, this difference was due almost entirely to the increased incidence of acute complications in the presence of solitary stones; namely, acute cholecystitis, gangrene, empyema, and acute pancreatitis (Fig. 4).

The mortality rate in surgery of the biliary tract is definitely influenced by the presence of complications. This fact is borne out in the present study, there being 3 deaths with a mortality rate of 3.65 per cent in the 82 cases of solitary stone as compared with 5 deaths and a mortality rate of 1.63 per cent in the 305 cases of multiple stones. The overall mortality rate for the entire series of 387 cases was 2.06 per cent. The causes of death are listed in Table VI.

DISCUSSION

There is at present no unanimity of opinion among the medical profession as to what advice should be given the patient who has gallstones which are not producing symptoms, and there are frequent instances in which such patients are advised to have nothing done surgically unless symptoms occur. It is our impression that the attitude is more uniform

TABLE IV.—DIAGNOSIS BY CHOLECYSTOGRAPHY

	No. of proved cases solitary stones	No. of proved cases multiple stones	Percentage of error
X-ray report solitary stone (51 cases)	32	19	37.25
X-ray report multiple stones (139 cases)	7	132	5.03

TABLE V.—COMPARISON OF FREQUENCY OF COMPLICATIONS

Complications	305 cases of multiple stones		82 cases of solitary stones	
	No.	Per cent	No.	Per cent
Acute cholecystitis	33	10.82	15	18.29
Empyema	6	1.97	3	3.66
Hydrops	14	4.59	3	3.66
Grangrene	9	2.95	4	4.88
Common duct obstruction				
Stone	21	6.88	5	6.09
Extrinsic pressure	1	0.33	2	2.44
Internal biliary fistula	1	0.33	0	0
Acute pancreatitis	4	1.31	2	2.44
Carcinoma of gall bladder	2	0.66	0	0
Total complications	91	29.84	34	41.46

when it concerns the solitary gallstone, for many physicians believe that the typically large solitary stone is incapable of becoming impacted in the bile ducts and that its presence is accordingly of little importance in the patient who does not have digestive disturbances which are referable to the biliary tract. Boyd has made the statement that "As regards biliary colic, it is true of the gall bladder as of the kidney that little stones like little dogs, make the most noise. A large stone is more likely to remain in the gall bladder, more or less silent."

TABLE VI.—CAUSES OF DEATH

Solitary stones (82 cases)	No. of deaths	Per cent
Common duct stone, pulmonary embolism (autopsy)	1	1.22
Gangrenous cholecystitis with perforation	1	1.22
Hypertensive heart disease with cardiac failure	1	1.22
Total	3	3.66
Multiple stones (305 cases)		
Cholangitis with obstruction of bile ducts (autopsy)	1	.33
Hypertensive heart disease with cardiac failure	1	.33
Hypertensive heart disease with cardiac failure, wound disruption	1	.33
Hypertensive heart disease with cerebrovascular accident	1	.33
Sudden death cause undetermined (autopsy)	1	.33
Total	5	1.65

Fig. 5. Photograph of solitary stone impacted in the ampulla of Vater.

The close correlation between the incidence of solitary stones in this series of cases, all of which were symptomatic, and the incidence of the asymptomatic solitary stones in Truesdell's series suggests that they are just as prone to produce symptoms as are their multiple counterparts. Furthermore, they produce the same signs and symptoms with about the same degree of frequency. We have been impressed with the finding of complications of the disease in 41.46 per cent of the patients with solitary stone as compared with 29.84 per cent of the patients with multiple stones, and a surgical mortality rate which was twice that attending the management of the patients with multiple stones. The increased incidence of complications was due almost entirely to the relatively larger number of cases of acute cholecystitis, empyema, gangrene, and acute pancreatitis. The impaction of a large stone in the ampulla of the gall bladder will not only occlude the cystic duct but is quite apt to interfere with the circulation to the gall bladder, resulting in increased edema, inflammatory reaction, and even gangrene. This reaction may be sufficient to cause involvement of adjacent structures. In this series there were 2 cases of obstructive jaundice due to occlusion of the common bile duct by extrinsic pressure, the duct being free of stones in each instance. There were also 2 cases of acute pancreatitis associated with acute cholecystitis in which the sole etiologic agent found was a large stone impacted in the ampulla of the gall bladder.

There were 5 instances in which the solitary stone was found in the common bile duct. It is well known that stones can form in the ducts or that they can migrate there from the gall bladder. An example of such a migratory stone concerns a patient 72 years of age who

was known to have a "solitary stone" in her gall bladder 14 years before operation. When admitted to the hospital she was jaundiced and acutely ill. At operation she was found to have a gallstone measuring 5.0 by 2.2 centi meters impacted in the ampulla of Vater together with an acute ulcerative and gangrenous cholecystitis. The distal end of the stone extended into the duodenum and bore a constriction where it was held by the sphincter of Oddi. No other stones were found in the biliary tract (Fig. 5).

This study would indicate that there is no logical reason for regarding solitary gallstones as any different from multiple stones in their ability to produce symptoms. In fact, the increased incidence of complications and the increased mortality rate which we have found make us believe that they are more dangerous to the patient than multiple stones, and that cholecystectomy should be the treatment of choice even when asymptomatic solitary stones are reported by the roentgenologist. Gallstones are gallstones whether single or multiple, large or small; their behavior is the same and their treatment likewise should be the same.

CONCLUSIONS

1. Solitary gallstones were found in 21.18 per cent of 387 consecutive cases of cholecystitis with cholelithiasis.

2. Solitary stones occurred slightly oftener in the male than in the female.

3. Complications occurred in 41.47 per cent of the cases of solitary stone as compared with 29.84 per cent for the cases of multiple stones.

4. Their surgical management resulted in a mortality rate of 3.65 per cent as compared with a mortality rate of 1.63 per cent for the multiple stones.

5. A cholecystographic report of the presence of gallstones is highly reliable. Any report as to the number present is unreliable.

6. The demonstration of a solitary gallstone by cholecystography is as much an indication for cholecystectomy as is the report of multiple stones.

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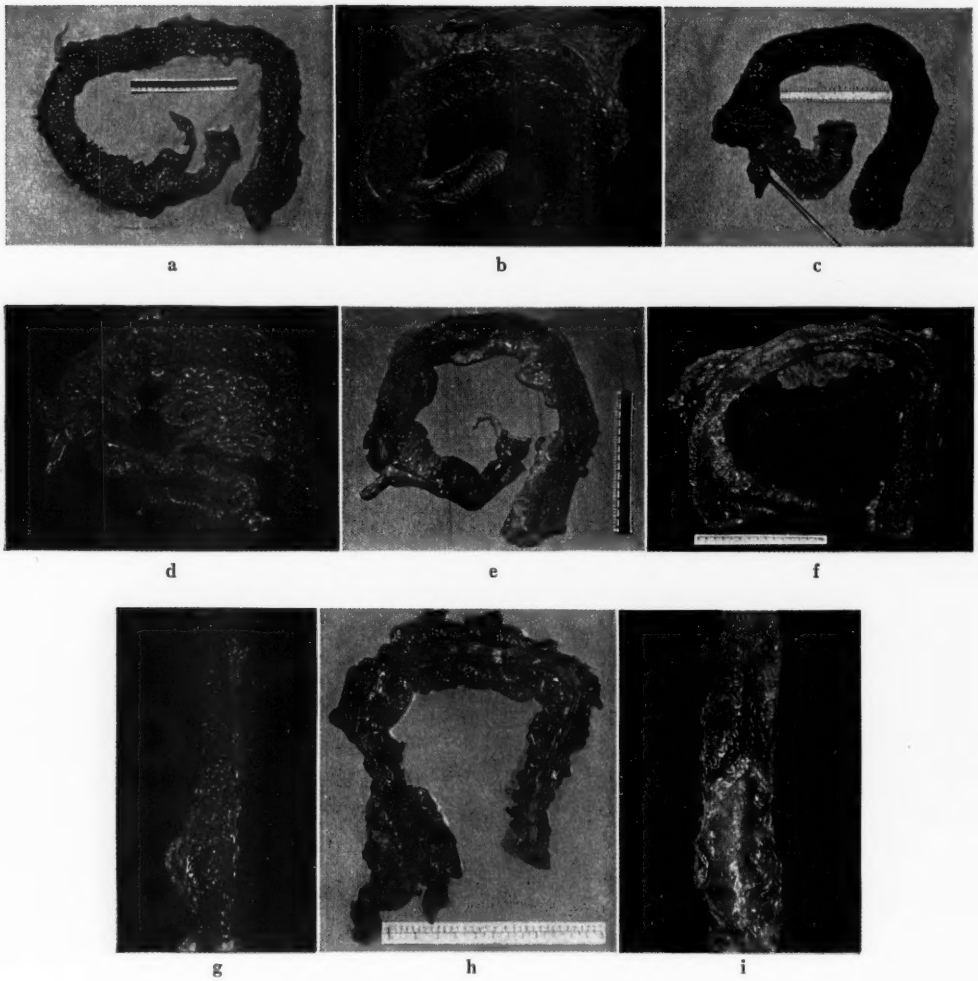

The Selection of an Operative Procedure for Patients with Medically Intractable Ulcerative Colitis.—Harry E. Bacon and Howard D. Trimpi

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THE SELECTION OF AN OPERATIVE PROCEDURE FOR PATIENTS WITH MEDICALLY INTRACTABLE ULCERATIVE COLITIS

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THERE is perhaps no illness whose treatment has so completely defied all efforts of standardization as has idiopathic ulcerative colitis. Its etiology has not been determined, its course is unpredictable, and its management is without established rule. Indeed, it is this nonconformity and departure from the usual among diseases that has so greatly gendered and nourished the many biases and misconceptions that even today prevail in no small number. It is not our purpose here to offer any panacea, nor to attempt to delineate a system of surgical procedure suitable for universal application, but we do hope that our study will add to the already abundant testimony which pleads for a unification of effort between the physician and surgeon toward the welfare of every patient made invalid by the ravages of the disease.

Pertinent to this project is a statement appearing in a paper by Willard, Hundley, Pessel and Bockus which is recorded as follows: "In our experience, no single therapeutic measure is particularly effective in any number of patients. A regimen including a variety of procedures would seem to offer the best chance of success in any single case." In the severer forms of the disease, medical management has proved insufficient. The justification for surgical intervention has been demonstrated by many. Surgical management, to be flexible and applicable to a wider selection of patients, must include a variety of acceptable and proved avenues of procedure, and with this in mind we would consider present day operative approach and submit a technique which has been of much practical merit in our hands.

Chronic ulcerative colitis generally assumes a form that responds to conservative measures. The severer manifestations seem to be limited to about 20 per cent of cases, and it is this group that surgery is so often requisite, yet so often belatedly inaugurated. The dangers of procrastination in these patients not responding to conservative regimen are all too evident. Indeed, if we are to see substantial reductions in morbidity and mortality, intervention by the surgeon, whether or not he elects to operate, must be obtained early in control. Even before diagnostic studies are complete the surgeon should have freedom in supervising all decisions. It is of incalculable import that an understanding exist between surgeon and patient from the beginning. Decisions to operate cannot be based entirely upon objective findings. To fix arbitrarily a scale by which to elect or reject such determinations must meet with defeat. Rhoads would establish the pulse rate of 120 as the dividing line between medical and surgical management. We cannot favorably subscribe to this criterion. Success can be achieved only through intimate surgeon-patient relationship where each change is evaluated and each step carefully adapted to the patient. We know of no other disease which so manifestly summons the art as distinguished from the didacticism in healing.

A significant number of patients with histories of repeated exacerbations and remissions are chronic invalids and human derelicts, kept alive, or "controlled," by medical methods but yet unable to resume wholesome activities. For these people we would champion surgical intervention, which has all too fre-

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Plate I. Operative specimens of chronic ulcerative colitis: a, H.S., colectomy; b, M.K., colectomy; c, E.K., colectomy —pointer indicates appendiceal abscess; d, W. N., colectomy; e, E.W., colectomy; f, D.R., colectomy; g, W.N. (same case as d), combined abdominoperineal excision of rectum—blue discoloration is dye injected to study lymphatics; h, M.B., colectomy; i, M.K., (same case as b), combined abdominoperineal excision of rectum.

quently been reserved as a lifesaving and emergency undertaking and has not been fully exploited from the standpoint of salvaging and rehabilitating the medical cripple. In contrast to the viewpoint expressed by Andresen to the effect that too many patients are needlessly subjected to surgery, it is our opinion that too many are being denied surgery.

In our series, 249 patients with ulcerative colitis were studied and treated. Of this number, 45 or 18 per cent underwent some type of operation. The remaining were managed conservatively, and generally the results in this group have been successful. We shall refer herein only to the former whose disease had reached a pathologically advanced state and surgical interference became obligatory.

ILEOSTOMY

The most common operation performed for ulcerative colitis is ileostomy. It is often made use of where a lifesaving course of action is demanded. It has been considered by many as a definitive procedure for the cure of ulcerative colitis and, although this approach has the advantages of a one stage operation, it is to be condemned in the light of present day experience relative to the hazards of leaving in situ a degenerated and diseased large bowel which may at any time give rise to grave complications. Patients treated by ileostomy alone usually improve rapidly, gain weight, and return to useful activities, only to reach a point where further improvement lags and a decline in health ensues. Arthritis (31), constitutional regressive changes, and toxemia may occur. Thorlakson found that a recurrence of all the features of a fulminating colitis with fever, necrosis, and perforation, can subsequently develop despite the presence of an ileostomy. He reports a death due to this unfortunate series of events which occurred 18 months after ileostomy. The risk of carcinomatous degeneration in the defunctionalized colon is by no means averted (24). Distressing hemorrhage from the rectum may persist despite ileostomy (26).

Patients do not always respond dramatically to ileostomy. This is particularly true in the acute, fulminating phases of the disease where mortality rates are high with or without surgery. Cave (14) reported a mortality rate of 53 per cent for late emergency ileostomy in these advanced, acutely ill patients, while Cattell (10) cites an even higher rate of 75 per cent. The concensus among most surgeons is that such poor risk patients should not be subjected to operation. In this regard, Ault (2) is rather emphatic and observes that if conservative measures are employed, a remission in the disease may result and surgery can be performed at a more opportune occasion. We would concur with this program in general, but whenever such a case arises we feel the surgeon must beware of too decisive a preliminary judgment. We know that in this group medical mortality is exceedingly high. We also realize that a striking feature in these severely ill people is the entire nonconformity of reaction to specific measures which the disease may take. Each decision must, therefore, be conditional. Heroic regimen, including the performance of a simple loop ileostomy under local anesthesia and supported by the administration of multiple whole blood infusions (sometimes numbering between 20 and 30 pints), may save a life. In other hopelessly advanced, fulminating cases we are inclined to agree with Paine, who suggests a primary colectomy with ileostomy inasmuch as there is nothing that can be lost, and the chance of operative success is not entirely void. Our attitude regarding this issue is based largely upon recent achievements in surgical preparation where multiple blood infusions are the keynote to success, and the utilization of the newer antibiotics of great material importance.

COLECTOMY

The removal of all ulcerated and diseased bowel is now a prominent feature in management where the disease has become medically irreversible. As Kiefer and Jordan (25) have stated, "the medical treatment of chronic idiopathic ulcerative colitis must be regarded as a control and not a cure—complete colectomy is the only actual cure of chronic ulcerative colitis now available."

Like other matters pertinent to ulcerative colitis, the indications for colectomy cannot be rigidly standardized. In general, the following are considered more or less mandatory: per-

sistent sepsis and toxemia that continues despite heroic medical effort, pericolic abscesses and fistulas, impending perforation, structures with partial or complete obstruction, pseudopolypoid degeneration, carcinoma, and persistent, painful anorectal disorders. Requiring slightly more latitude are dysfunctions secondary to the toxemia of ulcerative colitis such as arthritis, anemia, dermatoses, impending acute liver degeneration, and degenerative changes in other organs. The medical invalid, subject to periodic exacerbations of severe colitis, must be considered a candidate for colectomy. Yet one must be ever mindful of the dangers and possible complications entailed in performing this operation.

The decision to elect colectomy in prolonged chronically ill patients should be significantly influenced by a realization of the dangers of carcinomatous degeneration. An appreciation of this occurrence can be gained from many references. Brust and Bargen point out that the percentage of persons who have carcinoma following chronic ulcerative colitis is considerably greater than the percentage of persons in the general population who die of cancer of the intestines, including the rectum. They cite an incidence of 2.5 per cent in a series of 800 cases. Bargen, Jackman, and Kerr (6), in a group of 871 cases, record an incidence of 3.2 per cent. Cattell and Boehme (11) report carcinoma in 2 per cent of 450 cases at the Lahey Clinic. It is, however, significant that with increased severity of the disease there is a higher incidence of carcinoma. Cattell and Sachs (12) found this to be evident, inasmuch as 7 per cent of those operated upon at the Lahey Clinic had carcinoma complicating the colitis. With prolongation and chronicity, the incidence of carcinoma further rises. Colcock reported that of those patients having chronic ulcerative colitis 9 years or more, 1 out of 3 developed carcinoma. Bargen (5) supports this point of view by his studies which demonstrate that carcinoma is particularly prone to occur in the colon that has most frequently undergone repeated attempts at healing, following repeated degenerative exacerbations. Needless to state, when carcinoma does complicate ulcerative colitis, the prognosis is usually hopeless.

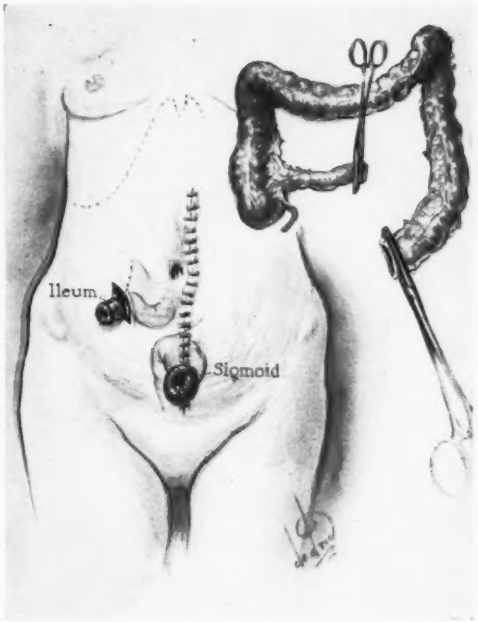

Fig. 1. Primary colectomy with ileostomy, plan of procedure. Left paramedian incision, permanent ileostomy and temporary sigmoidostomy are illustrated. Insert depicts extent of bowel excised.

PRIMARY COLECTOMY WITH ILEOSTOMY

It has been our recent practice to perform primary colectomy with ileostomy instead of the usual multiple stage operations. By colectomy, we refer to the complete extirpation of the colon including a segment of terminal ileum down to the midsigmoid. The sigmoidal stump is brought through the lower pole of the abdominal incision to form a temporary sigmoidostomy, and the proximal ileal stoma provides the permanent ileostomy. This technique is by no means rare and has been described in many of the older surgical texts. Miller and his co-workers have reported their experiences with its utilization in patients suffering from advanced ulcerative colitis, and it is of interest to note that the procedure was evolved in their surgical practice through a process of evolution which began with ileostomy and included many of the multiple stage methods. Cave (13) reports having performed primary colectomy on 4 occasions.

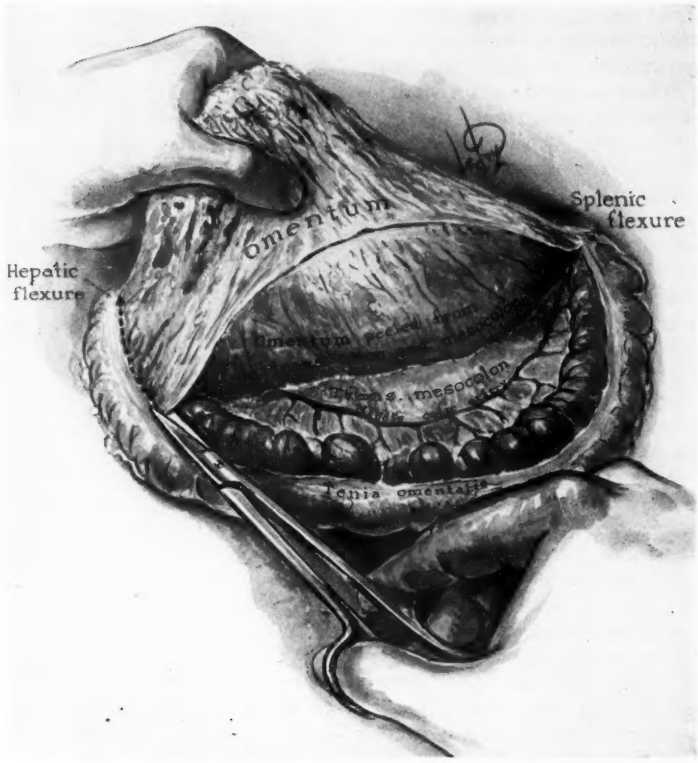

Fig. 2. Preliminary separation of the omentum from the transverse colon.

The advantages of a primary colectomy and ileostomy in one stage are many. The patient is subjected to fewer operations, and his improvement following colectomy with ileostomy is more rapid than following ileostomy alone. Of much practical value is the ease with which colectomy may be carried out unhindered by the scars and adhesions of previous surgery, and free from the necessity of circumventing or revising the previous ileostomy. The risk of contamination by material from the stomas of the existent ileostomy is avoided.

Many times the early removal of the colon is of special import. Intramural or appendiceal abscess formation, impending perforation, impending carcinoma, and intractable hemorrhage often admit of no less radical a procedure. In pseudopolypoid disease it is well to perform colectomy as early as possible (37).

We have noted less complications referable to ileostomy following primary colectomy than after ileostomy alone. The risk of infectious processes arising from the diseased large bowel, such as abscesses and enterocolic fistulas, is eliminated. Adhesions are fewer and less dense.

In performing primary colectomy we have incorporated several safety features which we believe to be significant. The first phase of the operation consists in the division of all the peritoneal and ligamentous attachments of the bowel with the exception of the mesentery. The colon is thus mobilized and the most difficult part of the operation, i.e. the freeing of the splenic flexure, accomplished without sacrifice of the blood supply, so that at any time, should the patient's condition demand, the operation may be interrupted and safely ter-

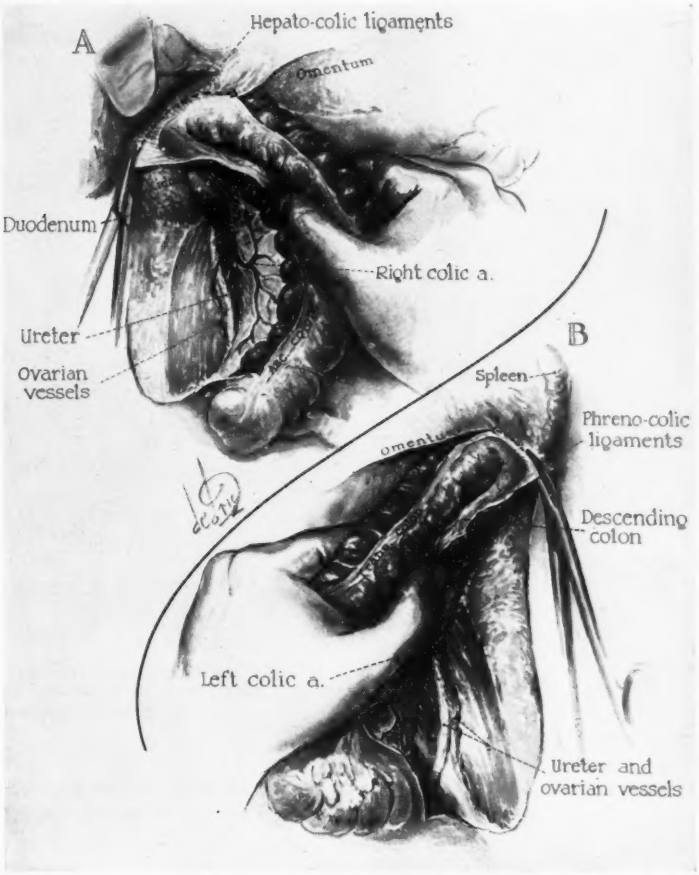

Fig. 3. A, Incising right lateral peritoneal reflection and retracting the colon medially. Dotted line indicates division of the hepatocolic ligaments. B, Incising left lateral peritoneal reflection. Dotted line indicates division of phrenocolic ligament.

minated. After mobilization of the colon, ligation of the blood vessels and division of the mesentery and mesocolon proceed rapidly. The bowel is not divided until the entire colon and a portion of the ileum are delivered through the incision, thus reducing dangers of contamination. The omentum is usually preserved, and where it is long enough, it can be split and each leaf placed in a paravertebral gutter. The operating time is reduced by making no attempt at reperitonealization. Deperitonealization in our series has produced no ill effects, and we are in agreement with Robbins, Brunschwig and Foote (32), who, in their clinical and experimental observations, noted no complications referable to leaving surfaces bare of peritoneum.

TECHNIQUE

The plan of procedure is depicted in Figure 1 which illustrates the left paramedian incision and shows schematically the extent of bowel to be resected and locations of permanent ileostomy and temporary sigmoidostomy.

Upon entering the abdominal cavity, brief exploration is made of the abdominal organs,

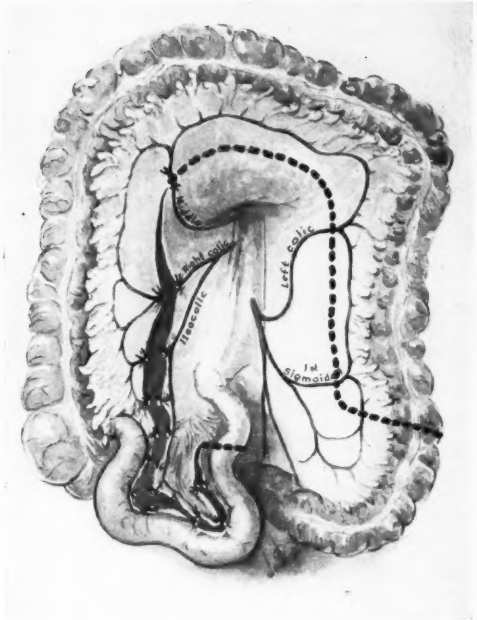

Fig. 4. Division of the mesentery, illustrating the ligation of the principal blood vessels.

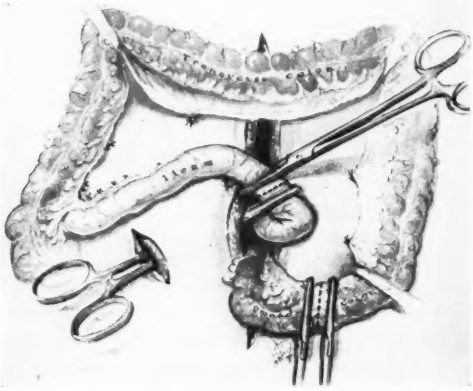

Fig. 5. Division of the ileum and sigmoid colon to form the permanent ileostomy and sigmoidostomy, respectively.

and particular attention is paid to the ileum to determine whether or not extension of the disease has occurred. Involvement of the ileum has been cited by McCready, Bargen, Dockerty, and Waugh to have occurred in 28 per cent of 103 cases of diffuse thromboulcerative colitis. Inspection of the ileum will show the presence of exudate, petechial hemorrhages, edema, and induration when inflammatory involvement has taken place.

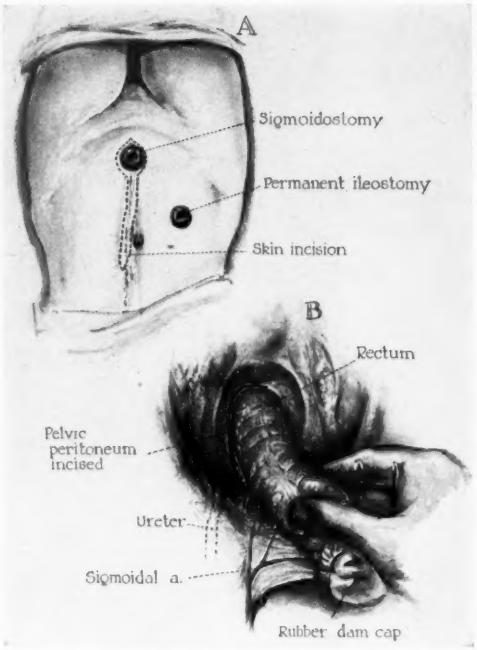

Fig. 6. Combined abdominoperineal excision of the rectum. A, Left paramedian incision with removal of old scar. B, Dividing the left leaf of peritoneum in mobilizing the rectosigmoid.

Dissection begins with the stripping away of the omentum from its attachments to the transverse colon (Fig. 2). This is easily done and little bleeding is encountered. Should the omentum be densely adherent, due to inflammation of the bowel wall, some difficulty will be encountered, and rather than continue with this maneuver, the surgeon elects to remove the omentum with the diseased bowel.

The ligamentous attachments of the colon are next divided, beginning the dissection with the incision of the peritoneal reflection on the right and mobilizing the cecum and appendix so that they can be retracted medially (Fig. 3). The ureter, kidney, and duodenum

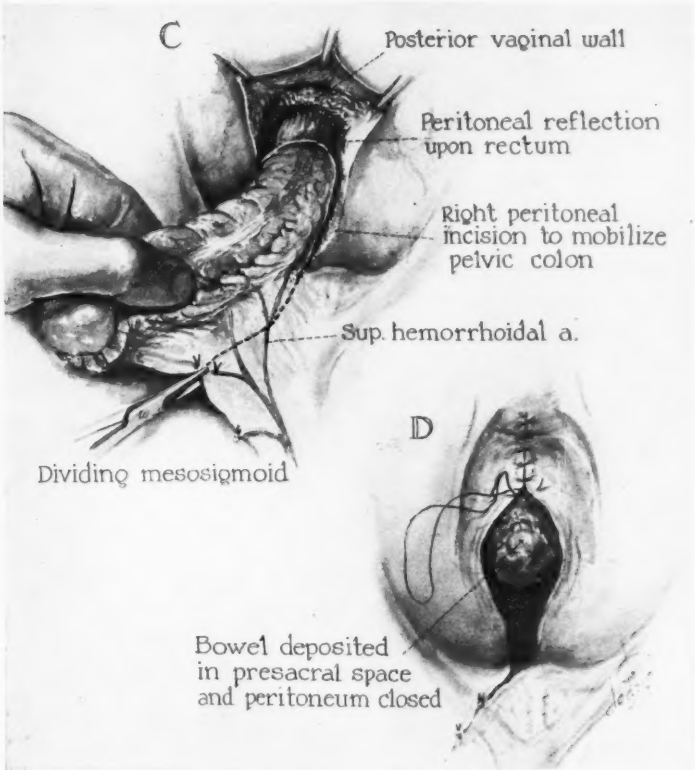

Fig. 7. C, Dividing the right leaf of peritoneum in mobilizing the rectosigmoid and anterior dissection down to the posterior vaginal wall. Posteriorly the dissection is carried down to the coccyx. D, Stump of sigmoid colon and mobilized rectum are deposited in the presacral space and the peritoneal floor is reconstructed.

are identified as the dissection proceeds superiorly. By exerting traction on both the transverse and ascending colons, the ligamentous attachments from the liver are brought into view and divided. The left colon and upper sigmoid are next mobilized by incising the lateral peritoneal reflections. The left ureter and kidney are identified. By drawing the descending and transverse colons downward while an assistant retracts upward and laterally on the left costal margin and abdominal wall, the splenic flexure can be visualized and the phrenocolic ligament divided. The colon will now be found to be mobilized, and attention can be directed toward ligating the blood supply and dividing the mesentery and mesocolon.

A point on the ileum about 12 inches proximal to the ileocecal valve is chosen, but the operator must be certain that this is well proximal to any inflammatory involvement, and at this site the mesentery is divided and the mesenteric blood vessels ligated. The division of the mesentery proceeds to the cecum and the mesocolon is divided from right to left. Each large colic vessel is ligated with silk. The mesocolon is divided down to the midsigmoid to an extent that the sigmoidal bowel can be mobilized to permit its being drawn through the lower pole of the incision to form a sigmoidostomy. As a general rule it is necessary that ligation and division of the first and second sigmoidal arteries be carried out (Fig. 4).

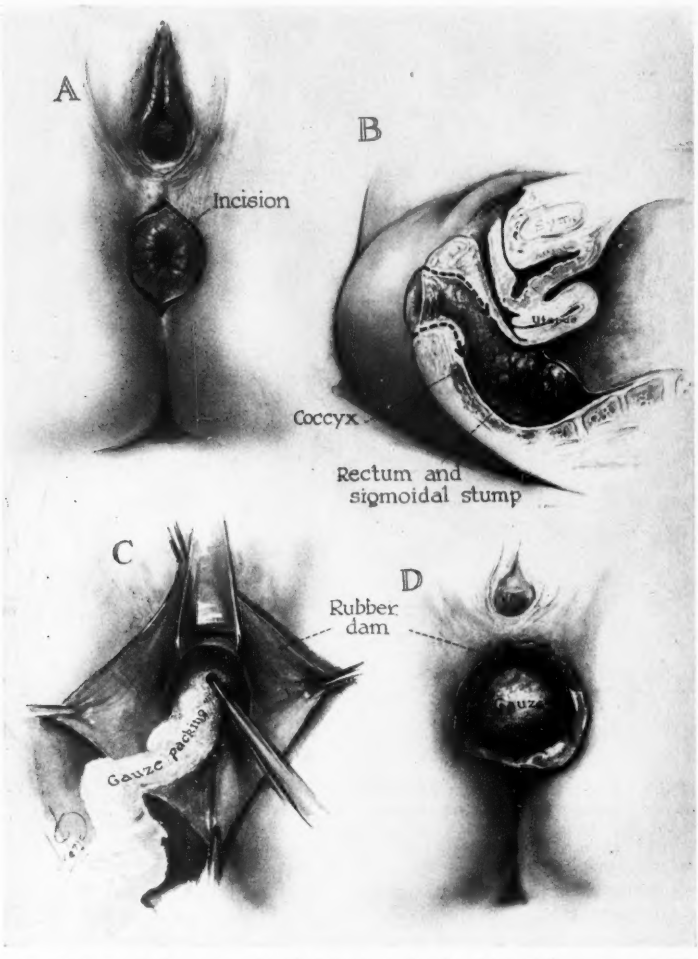

Fig. 8. Perineal phase of combined abdominoperineal excision of the rectum. A, Bi-elliptical incision circumscribing anus. B, Plan of dissection. Sphincter muscles are excised with specimen. Levators are incised close to the bowel. C, Rubber dam has been placed in wound and 2 inch vaginal packing is inserted. D, Completion of procedure showing Mikulicz pack in place.

The next step is the division of the ileum. A stab wound is made in the lower right abdominal quadrant at a site chosen for the permanent ileostomy which should be separated by several inches from the right anterior superior spine and from the umbilicus, so that later a bag may be satisfactorily fitted. A straight clamp is inserted through this incision and applied to the ileum at the point selected for division. A second clamp is placed distally, and the ileum is sectioned (Fig. 5). The proximal segment is drawn through the stab wound so that at least 4 centimeters protrude beyond the skin margin. The rent in the mesentery is then sutured to the anterior abdominal wall with interrupted sutures of No. 00 chronic catgut. Care must be exercised that no sutures be placed in the bowel serosa.

The sigmoid colon is next divided between clamps at the site chosen for the temporary sigmoidostomy. After this division the specimen is delivered from the field, and the abdominal wound is closed with interrupted figure of 8 sutures of number 30 steel alloy wire in the peritoneum and fascia, and continuous sutures of number 25 steel alloy wire in the subcutaneous tissue and skin. A mushroom catheter is placed in the ileostomy and held in place by a pursestring suture of catgut. A second mushroom catheter is placed in the sigmoidal segment and fixed in position by a Daniel clamp.

In preparation and in the postoperative management of these patients, the nonabsorbable sulfonamides are widely utilized (3). For a period of years it was customary in our department, to administer sulfathaladine preoperatively to all patients undergoing bowel surgery. The use of this drug was continued postoperatively. In recent months we have found cremothaladine to be superior to sulfathaladine for routine use. The usual dosage is 8 cubic centimeters, four times daily. Postoperative complications have been reduced by this method of therapy and we feel that a wider selection of operative procedure has been made available.

Electrolytic and fluid balance must be carefully controlled. A Miller-Abbott tube which was inserted preoperatively to maintain continuous decompression and also, as suggested by Thorlakson, to assist in the retraction of the small intestine during the operation, is connected to suction and frequently irrigated. Wangensteen suction is also applied to the ileostomy tube; as soon as the ileostomy begins to function well the Miller-Abbott tube is withdrawn. When ileostomy drainage becomes profuse it will be necessary to remove the mushroom catheter and apply an ileostomy bag, several of which should be kept on hand for early postoperative use. The Koenig-Rutzen bag is the most popular in use, but in recent months we have found the Torbot bag to be as satisfactory and less expensive.

Ambulation is encouraged within the first 24 hours. Antibiotics are administered in the postoperative period until the temperature curve is entirely normal. The patient will ordinarily convalesce rapidly, but it is advisable that he continue in the hospital or remain under strict observation for a period of at least 3 weeks postoperatively.

A most common complication is a loss of electrolytes and a disturbance in fluid balance which may occur in the first week after the establishment of an ileostomy (21). Close attention must be paid to blood chemistry values. Ileostomy patients may lose from 1,000 cubic centimeters to 6,000 or 7,000 cubic centimeters of fluid daily, and about 91 per cent of their output of sodium will result through this channel (34). Frequent infusions of saline, Hartmann's, and Ringer's solutions as well as Darrow's and hypertonic saline solutions are required. Blood is freely administered where serum protein levels fall, even though normal hemoglobin and red cell counts may be maintained (8, 16). Daily urine specimens are collected for determining chloride values, a laboratory procedure which is simple and inexpensive (20).

RESECTION OF THE RECTUM

It is indeed a rare case of ulcerative colitis that does not exhibit rather marked inflammatory involvement of the rectum. Vaughan and one of us (H.E.B, 4.), observed that the disease begins in the rectum in over 90 per cent of cases. Jones reported that 93 per cent of cases seen at the Cleveland Clinic had their origins in the rectum and spread upward into the colon. This has been confirmed by Bargen and others (6, 7). In Jordan's series of 430 cases with ulcerative colitis the rectum was involved in 407, or 94 per cent. Kasick, Weigarten, and Brown, in reporting 7 cases of carcinoma complicating ulcerative colitis in a consecutive series of 143 patients, found that 4 of these occurred in the rectum. Miller and co-workers performed 1 colectomy in 24 cases including a number of primary colectomies with ileostomy leaving the distal sigmoid and rectum in situ. In a followup note, they cite 2 deaths which occurred due to hemorrhage and infection in the rectum and sigmoidal stump. One of these patients died after the lower sigmoid had perforated.

With the exception of rare instances, we do not believe that colectomy is complete

without extirpation of the rectum. Depending upon the condition of the patient and the severity of rectal involvement, an interval of one to several months is allowed before abdominoperineal excision is elected. The patient is prepared by daily instillations of sulfathaladine suspension into the sigmoidostomy for at least a week prior to operation. Other preparation is similar to that prescribed for major bowel surgery.

The technique employed is similar to the Miles abdominoperineal excision except that no effort toward radicability is made. Figures 6, 7, and 8 illustrate the steps of this procedure. No attempt is made to repair the perineal wound, but instead, a Mikulicz type pack is employed for hemostasis.

ILEOSIGMOIDOSTOMY

We do not feel it good policy to restore the bowel continuity once ileostomy has been performed, but in a few selected cases where the rectum and low sigmoid are free from disease, ileorectostomy or ileosigmoidostomy may be carried out. We mention these operations because they are occasionally acceptable, but we would condemn the practice of leaving in situ the diseased rectum following colectomy in anticipation that rectosigmoid inflammation will subside enough to permit anastomosis. It is only in those rare cases which do not present rectal disease prior to colectomy that we have attempted ileosigmoidostomy. In our series, 3 patients were subjected to this procedure. The results in 2 were satisfactory and the patients successfully rehabilitated. One patient developed a spread of the disease to involve the ileum.

VAGOTOMY

Vagotomy has been a recent innovation in the surgical management of chronic ulcerative colitis. Dennis and Eddy (19), Dennis (18), and Thorek, have recorded promising results in early cases. As yet no definite conclusions can be drawn (17). The procedure has been reserved mainly for those patients who in the course of their illness have failed to respond to medical treatment, but do not present the picture of advanced disease with scarring and fibrosis. Vagotomy is considered ineffectual where narrowing of the bowel lumen has occurred.

It has been rather difficult on our part to comprehend the exact rationale for vagotomy in the common, or as Jones described it, the "so-called universal" type of nonspecific chronic ulcerative colitis which begins in the rectum or sigmoid and spreads cephalad. We will concede that the parasympathetic (cholinergic) system, namely, the vagus and sacropelvic nerves, is most important, and that the vagus, which arises from the medulla, through its branches directly innervates a large portion of bowel. But we must concur with Portis, if neurogenic factors are to be considered in etiology, "that in the early and localized focus of this disease (idiopathic ulcerative colitis) the sacropelvic nerves and their innervations in these structures (rectum and sigmoid) are a primary source of the physiologic disorder. . . . Since emotional stimuli are transmitted over both vagus and sacropelvic nerves, the end physiologic effect of overt stimuli is a disturbance in physiologic balance. The motor nerve, e.g., the vagus, causes contractions and peristalsis of the small intestine and relaxation of the ileocolic valve. The colon in turn has increased motility, for the same reason, up to and including the ascending limb of the splenic flexure. The sacropelvic nerve has the same physiologic effect on the distal part of the colon as the vagus exerts on the ileocolic portion."

Scott and Cantrell in experimental studies using the colonmetrogram demonstrated that sectioning the vagus nerves had little or no effect on large bowel motility and tone, whereas sectioning of the pelvic parasympathetic nerves produced rather marked changes. It is therefore evident that attention should be directed toward interrupting the sacropelvic parasympathetic supply to the primarily diseased rectum and sigmoid rather than the vagus, if control of the disease is to be expected through denervation.

STATISTICS

A variety of operations have been performed in our department in the treatment of 45 patients who presented changes characteristic of advanced ulcerative colitis necessitating surgical intervention (Table I).

TABLE I.—OPERATIONS

	No. of operations	Deaths	Mortality-%
Ileostomy	28	4	14.2
Ileosigmoidostomy	3	0	0
Colectomy	22	0	0
Abdominoperineal excision	17	0	0
Miscellaneous	17	0	0
Total	87	4	4.6

No criterion for cure of idiopathic ulcerative colitis can be set forth without including in it a report of the rehabilitation of the patient. This is the gauge by which all treatment must be measured. Medical endeavor alone often brings about remission of symptoms and temporary restoration of health, but complete cures are not in the majority (35).

By rehabilitation we wish to indicate a complete return to usual activities and occupation on the part of the patient without reservations. Despite the inconveniences of wearing an ileostomy bag these rehabilitated patients are free of depression, are active and happy. Rehabilitation follow-up results are as follows: total number colectomies, 22; deaths following hospital discharge, 2; number of patients rehabilitated, 19 or 86.3 per cent.

Two deaths occurred in our series following discharge from the hospital. One patient (a 9 year old girl) developed a progression of the disease with severe enteritis complicated by abscess formation and died 1 year after colectomy. The second patient died of fulminating bronchopneumonia 5 months after colectomy.

SUMMARY

1. Standardization in the management of chronic ulcerative colitis has not been possible. Patients do not react similarly to specific regimens and the ingenuity of the physician and of the surgeon alike is often tried to the utmost.

2. All advanced, seriously ill patients, should have the benefit of early surgical supervision, and an intimate surgeon-patient relationship must be established.

3. The management of no other disease lays such stress upon art as distinguished from didacticism in healing. Decisions are conditional, and there is no place for stubborn or opinionated tenets.

4. Ileostomy is not a curative procedure in itself and should be followed by colectomy.

5. Ileostomy in the acute, fulminating forms of the disease is not to be entirely condemned, as it can indeed prove to be a lifesaving measure particularly when supported by intensive blood transfusions and antibiotic therapy.

6. Colectomy is the primary contribution made by surgery toward the cure of chronic ulcerative colitis. It has been performed by many surgeons, with low morbidity and mortality rates.

7. A technique for primary colectomy with ileostomy is offered as a supplement to present day surgical procedures in the hope that its utilization will materially lessen the complications and difficulties often associated with the multiple stage operations.

8. Excision of the rectum is recommended for all cases with the possible exception of those rare instances in which there has at no time existed any apparent rectal involvement.

9. Conclusions relative to the value of vagotomy cannot as yet be drawn. Its rationale has not been made entirely clear.

10. In a series of 249 cases, 45 or 18 per cent underwent some form of operation. Operations performed totaled 87, with a mortality rate of 4.6 per cent.

11. Rehabilitation was successful in 86.3 per cent of patients undergoing colectomy.

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THE EFFECTS OF SODIUM AND CHLORIDE LACK ON INTESTINAL MOTILITY AND THEIR SIGNIFICANCE IN PARALYTIC ILEUS

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IN the course of treating a case of severe paralytic ileus it was observed that the urinary chloride concentration remained low for 8 days, despite a large intake of sodium chloride, and that the patient's clinical recovery on the ninth day coincided with a sudden rise in the urinary chloride level. A study of the blood and urinary biochemical changes in a subsequent series of 6 cases of paralytic ileus at the General Hospital, Johannesburg, revealed the same phenomenon in all, and showed that changes in the plasma chloride concentration ran roughly parallel with those in the urine. In all of the 3 cases in which it was estimated, the plasma chloride concentration was below 500 milligrams per cent (expressed as sodium chloride) before intravenous saline treatment was commenced, and rose to normal levels at about the same time as signs of peristalsis returned. In the most obstinate of these cases, an observation was made which prompted the present investigation.

The patient, a white woman, aged 47 years, had developed a distended, silent abdomen and was vomiting copiously 70 hours after a panhysterectomy for carcinoma of the uterus. Neostigmine (prostigmin) had been given intravenously 5 hours before in a dose of 0.5 milligram and had produced no noticeable effect. Chloride was absent from the urine by the Fantus (1936) test. An intravenous drip was set up and saline administered in a 5 per cent solution followed by an isotonic solution, at the rate shown in Figure 1. Within 2 hours of starting the intravenous hypertonic saline, normal intestinal borborygmi were heard and flatus was passed. The urinary chloride level had risen to 3 grams per liter by this time, and when neostigmine (0.5 mgm.) was given intravenously it provoked a bowel motion within 30 minutes. The cause of the ileus had apparently by no means been overcome, however, for when the intravenous fluids were discontinued overnight, the patient relapsed and again developed distention of the abdomen, with absent intestinal sounds, much vomiting, and a urinary chloride concentration which had fallen to 2 grams per liter. For the next 2 days she was kept on intravenous fluids, but, while bowel sounds became audible and vomiting ceased, no bowel motion occurred. Cessation of the intravenous infusion because of subcutaneous edema on the sixth postoperative day again resulted in a rapid decline in the urinary chloride concenrtation and in a second relapse of the ileus the following morning. With the urinary chlorides at 1 gram per liter neostigmine was given in the same dose as before and was entirely ineffective. A Cantor tube was passed and soon after the chloride level in the urine had been raised by further intravenous fluids, low-pitched intestinal sounds returned. Another intravenous neostigmine injection gave rise to abdominal cramps within 5 minutes and a bowel movement within 15 minutes, after which the patient's recovery was uneventful.

The unusually refractory course of the ileus in this patient suggested that the condition was the result of some factor which had produced at the same time a suppression of renal chloride excretion. As long as the urinary chlorides were maintained above 3 or 4 grams per liter, the intestine was able to contract and to respond to a neostigmine injection, but soon after the intravenous saline was stopped a rapid fall in urinary chlorides ensued and the bowel reverted to its state of virtual paralysis.

While Marriott (1947) and Aird (1948) have both suggested that paralytic ileus may sometimes result from salt depletion, no author, in the publications which have been available for study, appears to have investigated how far the plasma electrolyte depletion may be of importance in the etiology of paralytic ileus. The present communication describes some of the effects of low sodium and chloride concentrations on peristalsis, as observed in the isolated intestine of the rabbit, of the guinea pig, and of man.

From the Department of Pharmacology, University of Oxford. Laboratory investigation performed during tenure of a Nuffield Demonstratorship in Pharmacology at Oxford.

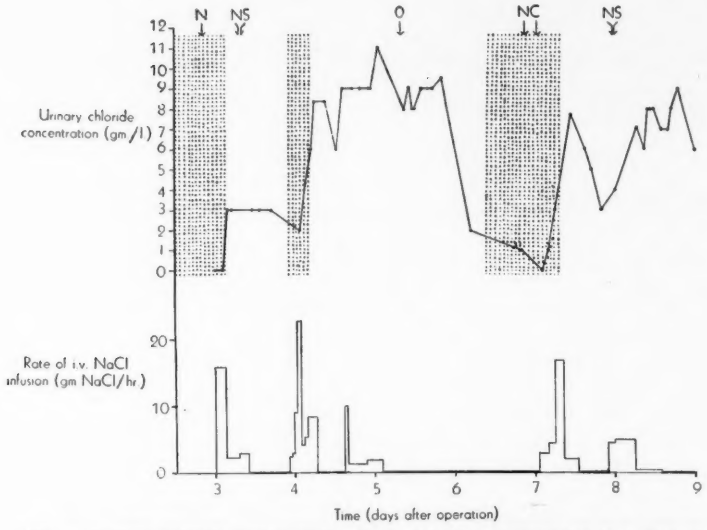

Fig. 1. Sodium chloride intake and urinary chloride concentration in a case of paralytic ileus following panhysterectomy. The upper curve represents the chloride concentration in grams per liter (Fantus test, 1936) in each specimen of urine passed, while the histogram indicates the rate of intravenous sodium chloride administration in grams per hour. Shaded areas show the duration of paralytic ileus as diagnosed by abdominal distention, vomiting, and absent bowel sounds. Time markings (abscissae) indicate midday on the 3rd to 9th day after the operation. *N*, intravenous injection of 0.5 mgm. neostigmine (prostigmin); *S*, bowel motion; *O*, onset of subcutaneous edema; *C*, Cantor tube passed.

METHODS

1. In the earliest experiments the technique of Trendelenburg (1917) was followed; the changes in length and in internal volume of a strip of rabbit or guinea pig intestine were recorded simultaneously. In this method the proximal, ligated end of a piece of intestine was attached to a lever which recorded its longitudinal contractions on a revolving drum, while the distal end was tied round a hollow glass tube filled with Tyrode solution. This tube led to a Marriotte bottle the height of which could be varied, thereby modifying the pressure inside the loop. The air above the Tyrode solution in the Marriotte bottle was connected to a piston recorder registering volume changes in the intestine. The organ bath containing the intestinal strip was filled to a 75 milliliter graduation mark with Tyrode solution maintained at 36 to 38 degrees C. A brisk stream of a 95 per cent oxygen 5 per cent carbon dioxide mixture was bubbled through the solution in the organ bath. Most of the experiments to be described were carried out on a 6 to 8 centimeter length of rabbit terminal ileum, but the findings were confirmed on rabbit jejunum and mid-ileum, and on guinea pig duodenum and terminal ileum.

The pressure within the lumen of the intestine was raised to 3 centimeters of Tyrode solution by elevating the Marriotte bottle. In the majority of the experiments the intraluminal pressure was raised to this level intermittently for 3 minutes at a time, being lowered well below zero pressure for the remaining 7 minutes of each 10 minute period. It was found subsequently, however, that if the increased internal pressure was maintained for long periods of time, peristaltic waves occurred in a fairly constant pattern for periods of 4 to 7 hours with little or no evidence of fatigue in 18 out of 21 preparations of rabbit gut. This finding confirms Trendelenburg's claim (1917) that rabbit intestine is not fatigued by long continued distention. When guinea pig intestine was used fatigue

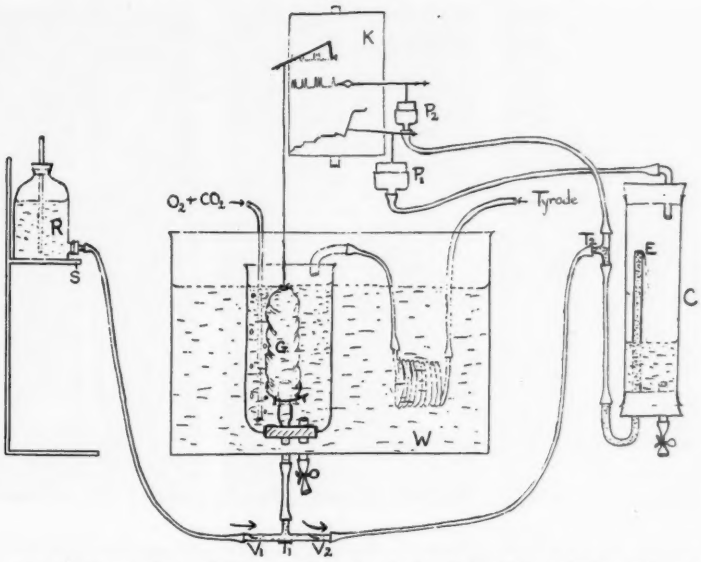

Fig. 2. Apparatus used in the modification (method 2) of Trendelenburg's (1917) method for studying propulsive efficiency of an intestinal segment, *G*. *C*, Outflow volume recorder; *E*, end of the tube conveying fluid from gut lumen into *C*; *K*, kymograph drum; P_1, P_2, piston recorders; *R*, reservoir of Tyrode solution; *S*, vertically adjustable stand; T_1, T_2, T-pieces; V_1, V_2, one way valves; *W*, water bath at 37 degrees C.

occurred much earlier, sometimes within 2 hours.

2. A modification of Trendelenburg's (1917) method was employed in later experiments, in which the propulsive efficiency of the intestinal strip could be estimated by collecting and measuring the fluid expelled by each series of contractions. This method was used on segments of human intestine, removed for carcinoma of the adjacent bowel, and transported to the laboratory immediately in oxygenated Tyrode solution. The distal end of the intestinal segment was tied round an extension from one limb of a glass T-piece, the remaining limbs of which were connected to one way valves, V_1 and V_2 (Fig. 2). One of these valves, V_1 allowed Tyrode solution from a reservoir, *R*, on an adjustable stand, *S*, to enter and fill the intestinal loop when it relaxed after each peristaltic contraction. The other valve, V_2, permitted fluid forced by contractions out of the intestinal lumen, to flow into a glass container, *C*, which communicated with a large, frontal-writing piston recorder, P_1. The entrance of fluid into *C* displaced air which produced an upward movement of the recorder, P_1, against the revolving kymograph drum, and *C* could be emptied, either by hand or with an automatic electrical relay, described elsewhere (Streeten and Vaughan Williams, 1950), after any desired excursion of the recorder lever against the drum. The outflow record consisted in a series of up-strokes separated, during quiescence of the gut, by horizontal lines. The magnitude of each contraction or series of contractions could be determined in terms of the volume of fluid ejected, by calibrating the recorder for known volumes of fluid injected with a syringe into the closed recorder system. The T-piece, T_2, and the lower end of the glass tube within the reservoir, *R*, were at the same horizontal level as the end, *E*, of the outflow tube within the recording chamber, *C*. At the height of each peristaltic contraction, the momentary rise in the fluid level within T_2 was recorded on the drum by the piston recorder, P_2. Longitudinal contractions were registered

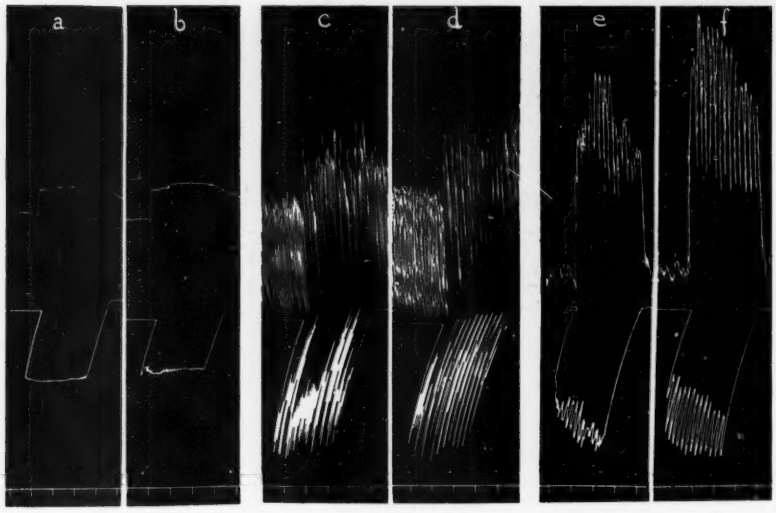

Fig. 3. Simultaneous record of the longitudinal contractions (upper tracing) and the volume changes (lower tracing) of a strip of rabbit terminal ileum, in response to raising the internal pressure to 3 centimeters Tyrode for 3 minutes at a time. The solution in the organ bath was varied as follows: a and b, Tyrode solution containing half the normal sodium chloride concentration (4 gm./l.); c and d, normal Tyrode solution (NaCl 8 gm./l.); e and f, sodium chloride deficient Tyrode solution, as in a and b, but with sufficient dextrose added (1.8 gm. in 75 ml. bath) to restore normal tonicity. Neostigmine methyl sulfate, 1 microgram, was added to the 75 milliliter bath, 16 minutes before each of the tracings, b, d, and f. Time in minutes.

on the drum by means of a lever to which the ligated, proximal end of the intestine was attached. The temperature was maintained at 37 degrees C. by means of a water bath, *W*, and a brisk stream of a 95 per cent oxygen 5 per cent carbon dioxide mixture was bubbled through the fluid in the organ bath throughout the experiment. The organ bath was refilled after emptying and was washed between experiments with Tyrode solution at 37 degrees C.

3. The apparatus, described elsewhere (Streeten and Vaughan Williams, 1950) for use in Thiry-Vella loops in dogs, was also employed on the suggestion of Dr. E. M. Vaughan Williams in the present series of experiments on isolated human intestinal segments. A metal tube was tied into either end of an 8 to 10 centimeter length of intestine immersed in oxygenated Tyrode solution at 37 degrees C. Tyrode solution at the same temperature was run into the lumen at the oral end and out from the aboral end at pressures which varied from 2 to 10 centimeters and which were kept the same at both ends. The rate of outflow of fluid from the aboral end was measured by means of the volume recorder described in 2. Through T-pieces connected with the tubes conveying the Tyrode solution into and out of the gut, the movements of the fluid resulting from contractions at either end of the intestinal segment were made to operate piston recorders which registered contractions on the kymograph drum. In this way the propulsive efficiency of the intestinal segment could be studied with both ends of the segment open, with fluid entering through the oral end (and not the aboral end, as in Trendelenburg's method), and without the unphysiological straightening of the intestine by its suspension between a fixed tube and a moving lever.

EXPERIMENTAL RESULTS

Normal peristalsis. An intestinal segment suspended in normal Tyrode solution by

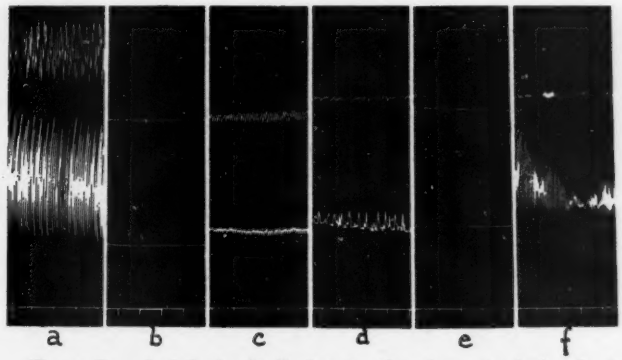

Fig. 4. Record of the longitudinal contractions (upper tracing) and volume changes (lower tracing) of a Trendelenburg preparation of rabbit terminal ileum with the internal pressure maintained at 3 centimeters Tyrode solution. The intestine was immersed in the following solutions: a, normal Tyrode solution; b, Tyrode solution without sodium chloride; c, Tyrode solution without sodium chloride, to which the normal sodium ion concentration (149 mEq./l.) had been restored by the addition of sodium lactate (1.15 gm. per 75 ml.); d, Tyrode solution without sodium chloride, to which the normal chloride ion concentration (143.5 mEq./l.) had been restored by the addition of bis-hydroxyethyldimethylammonium chloride (1.74 gm. per 75 ml.); e, Tyrode solution without sodium chloride, to which the normal tonicity had been restored by the addition of dextrose (3.6 gm. per 75 ml.); f, normal Tyrode solution. Time in minutes.

Trendelenburg's method shows longitudinal contractions only, unless the internal pressure exceeds a certain level, the "peristaltic threshold." When the distending pressure is raised above this threshold, peristalsis is initiated. This is shown in Figure 3c, where the upper tracing registers longitudinal contractions while the lower tracing records changes in the internal volume of the gut. When the intraluminal pressure was increased in this preparation from zero to 3 centimeters Tyrode solution, the upper lever rose, indicating shortening of the intestine, and the lower lever fell, as a result of dilatation of the gut, followed immediately by the onset of peristaltic waves. When, after 3 minutes, the pressure within the lumen of the intestine was lowered again to zero, the longitudinal tone returned to its previous level and peristaltic contractions ceased. If, on the other hand, the distending pressure was maintained for some time, it was found that in some preparations the peristaltic waves stopped for a time and then started again as shown in Figure 7a. In other observations there was no complete interruption, but the waves alternately declined and increased in amplitude. This variation in peristaltic activity was most obvious in guinea pig intestine, but was seen also in rabbit and human intestine, and confirmed the findings of Leo (1933), Meyer and McEwen (1947), and Streeten and Vaughan Williams (1950).

The addition of physostigmine sulfate or of neostigmine methyl sulfate (prostigmin) to the organ bath in concentrations of $1:7.5\times10^{7}$, promoted continuous peristaltic activity as is illustrated in Figure 7a. These drugs also increased the amplitude of longitudinal contractions and the tone of both the longitudinal and the circular muscle layers. With acetylcholine bromide, on the other hand, in concentrations of $1:1.5\times10^{8}$ to $1:7.5\times10^{5}$, the tone of both intestinal muscle layers was increased, but the amplitude of longitudinal and peristaltic contractions was usually decreased, though sometimes unaffected or increased.

Effects of deficiency in sodium chloride. When the gut was immersed in Tyrode solution from which the sodium chloride had been omitted, longitudinal and peristaltic contractions in response to distention of the intestine were absent, as shown in Figure 4b, and were not restored by making the solution isotonic

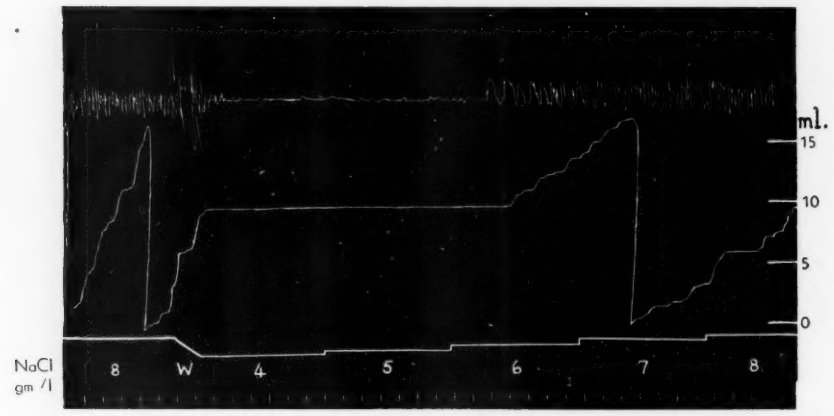

Fig. 5. Determination of critical sodium chloride concentration for propulsion by human cecum (method 3). The cecum, cannulated at both ends, was suspended in Tyrode solution of which the sodium chloride concentration was changed, as indicated by the ciphers, from 8 to 4, 5, 6, 7, and again 8 grams per liter. The upper tracing shows contractions registered by a piston recorder connected with the fluid entering the oral end of the cecum, while the lower line indicates the volume of fluid expelled from the aboral end and is calibrated in milliliters. The pressure at either end was 6 centimeters Tyrode. The large contractions recorded when the serosal surface of the cecum was washed, at *W*, with Tyrode containing 4 grams sodium chloride per liter were due to the mechanical effect of emptying and refilling the organ bath. It is seen that only very small contractions, producing no outflow of fluid, occurred when the sodium chloride concentration was 4 or 5 grams per liter, but that the contractions were increased and fluid propulsion became possible when the sodium chloride concentration was increased to 6 grams per liter, or higher. Time in minutes.

with the addition of dextrose (49.2 gm./l.) (Fig. 4e) or sucrose (93.4 gm./l.). As the concentration of sodium chloride in the fluid was raised from zero, a point was reached (at about 4 gm. NaCl/l. for rabbit intestine) at which peristalsis was negligible (Fig. 3a) but did return, though in waves of small amplitude, when dextrose or sucrose was added to restore isotonicity (Fig. 3e). If the sodium chloride concentration of the immersion fluid was raised a little further, the intestine regained the ability to transport fluid without the restoration of the normal tonicity in the medium. This is shown in Figure 5, where the peristaltic waves (top tracing) and the volume of fluid ejected from a piece of human cecum were recorded while the sodium chloride concentration was varied as indicated by the ciphers. It is evident that the peristaltic waves were able, with the intestine immersed in normal Tyrode solution (8 gm. NaCl/l.) to expel fluid from the gut, but were reduced to such an extent in Tyrode with 4 or 5 grams sodium chloride per liter that no propulsion of fluid took place. Only when the sodium chloride concentration had been raised from 5 to 6 grams per liter, did peristalsis become strong enough to transport fluid. For rabbit intestine the critical sodium chloride concentration was lower than for human gut and lay between 4 and 5 grams of sodium chloride per liter.

In order to determine whether the sodium or the chloride ion was the more important for normal intestinal motility in vitro, half or all the sodium chloride contained in normal Tyrode solution was substituted by equimolar amounts of various sodium salts (sulfate, nitrate, bicarbonate, lactate, and phosphate) or chlorides (choline and bishydroxyethyldimethylammonium chlorides). Figure 4 shows how a strip of rabbit terminal ileum, distended with a constant pressure of 3 centimeters was able to contract in length (upper tracing) and in volume (lower tracing) when immersed in normal Tyrode solution (a). When the fluid in the organ bath contained no sodium chloride (in b) contractions were absent, even when

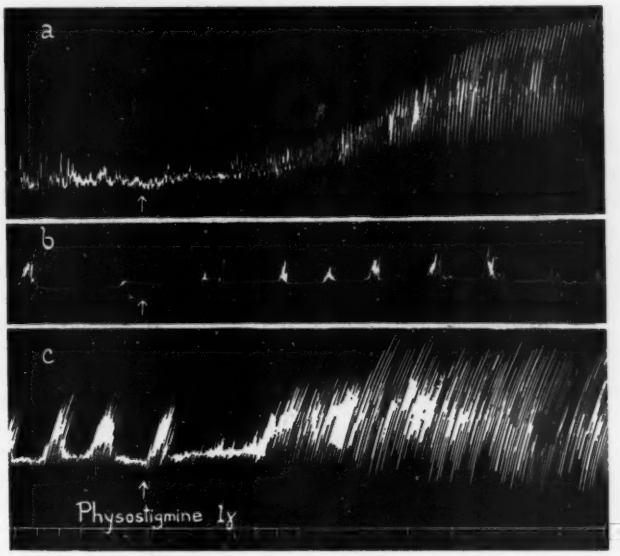

Fig. 6. Volume changes in a Trendelenburg preparation of rabbit terminal ileum at an internal pressure maintained at 3 centimeters. The gut is immersed in Tyrode solution containing 5 grams sodium chloride per liter in a and c, and 4 grams sodium chloride per liter in b. The arrows mark the times at which physostigmine, 1 microgram, was added to the 75 milliliter bath. Time tracing in minutes.

dextrose was added to make the fluid isotonic (in e) and the restoration of the normal chloride ion concentration (in d) was about as effective as the restoration of the normal sodium ion concentration (in c) in stimulating contractions which were still far smaller, however, than when both the sodium and the chloride ion concentrations were returned to their normal level (f). In the same experiments it was found that acetylcholine had no effect in the absence of sodium chloride and that, for the characteristic acetylcholine response the presence of sodium ions was all-important, whereas the chloride ion concentration was apparently of little consequence. In Tyrode solution with half the normal sodium chloride concentration the action of acetylcholine was retained, though reduced by about half as compared with its action in normal Tyrode solution. Physostigmine and neostigmine ($1:7.5\times10^7$) had no effect in the absence of sodium chloride and very little effect in Tyrode with half the normal sodium chloride content (Fig. 3b), even after the osmotic pressure of the solution had been made normal with dextrose (Fig. 3f). The minimal sodium chloride concentration necessary for the usual augmentation produced by physostigmine was found to lie between 4 and 5 grams of sodium chloride per liter for rabbit intestine. This is demonstrated in Figure 6 which records the peristaltic contractions of rabbit terminal ileum. Physostigmine, added at the arrows, is shown to stimulate peristalsis in Tyrode solution with 5 grams of sodium chloride per liter (a and c), but to have very little stimulant action when administered with the gut immersed in Tyrode solution containing 4 grams of sodium chloride per liter (in b).

Effect of the plasma abnormalities in paralytic ileus. In paralytic ileus there is characteristically a pronounced reduction in the plasma chloride concentration and a relatively slight fall in the plasma sodium level. The bicarbonate ion concentration is raised but usually not sufficiently to compensate for the chloride depletion. These changes were well

TABLE I.—THE COMPOSITION OF SOME OF THE SOLUTIONS USED

(Concentrations in milliequivalents per liter unless otherwise stated)

Constituent	1 Plasma in paralytic ileus*	2 Solution made up to resemble (1)	3 Normal Tyrode solution	4 Tyrode solution with ½ normal NaCl content
Na^+	136.1	136.1	149.3	80.8
K^+	4.1	4.1	2.7	2.7
Mg^{++}	not reported	0.2	0.2	0.2
Ca^{++}	not reported	3.6	3.6	3.6
Cl^-	85.0	85.0	143.5	75.0
HCO_3^-	34.9	34.9	11.9	11.9
SO_4^{--}	not reported	6.0	0.0	0.0
Lactate	not reported	17.7	0.0	0.0
Phosphate	not reported	50 mgm. NaH_2PO_4 per l.	50 mgm. NaH_2PO_4 per l.	50 mgm. NaH_2PO_4 per l.
Dextrose	not reported	1 gm./l.	1 gm./l.	1 gm./l.

*As reported by Falconer and others, 1939 (Case 24, on 12-29-37).

shown in one of the cases (No. 24) described by Falconer, Osterberg, and Bargen (1939), and an attempt has been made to study the motility of intestinal segments immersed in a solution with the same abnormalities in electrolyte composition (Table I). The anion deficit observed by these authors was balanced with sulfate ions in the concentration reported by Atchley and Benedict (1927) in intestinal obstruction, and with lactate ions. The deficient solution was actually prepared by dissolving in each liter of distilled water 4.50 grams sodium chloride, 0.31 gram potassium chloride, 0.20 gram calcium chloride, 0.01 gram magnesium chloride, 0.05 gram sodium biphosphate, 2.93 grams sodium bicarbonate, 0.43 gram disodic sulfate, 1.98 grams sodium lactate and 1.00 gram dextrose. Figure 7 records the peristaltic contractions of guinea pig intestine when immersed in such a medium. It is seen that while large contractions and a good response to neostigmine (added at the arrows) were present with the gut in normal Tyrode solution (a and c), very feeble contractions occurred with an almost insignificant response to neostigmine when the gut was bathed in the abnormal solution (b). Rabbit small intestine was less adversely affected by this solution. When human transverse colon was immersed in the abnormal fluid, Figure 8a shows that longitudinal contractions (middle tracing) were reduced, while peristaltic waves were absent (lowest line) and no fluid was transported by the intestine, as shown by the top line. The same intestinal segment in normal Tyrode solution (Fig. 8b) showed larger longitudinal contractions with fairly regular peristaltic waves and active propulsion of fluid as indicated by the upward movements of the lever which recorded the top tracing. Neostigmine failed to stimulate peristaltic contractions of the colon when in the abnormal solution (a), whereas in normal Tyrode solution (b) it increased the colon's rate of propulsion of fluid from 0.4 to 0.9 milliliter per minute. Human terminal ileum behaved in the same way, but human cecum retained some propulsive power though this was much reduced in the abnormal solution.

In view of the possible significance of the high blood urea so frequently encountered in paralytic ileus, the effect of urea on the isolated intestine was examined. In concentrations of 133 to 500 milligrams per 100 milliliters urea inhibited peristalsis only once, while in 4 experiments it was observed to have a slight stimulant action on the peristalsis of rabbit terminal ileum.

Stimulation of peristalsis in low sodium chloride solutions. In an attempt to find whether any substances were capable of stimulating the isolated intestine immersed in sodium chloride deficient solutions, the work of Lorente de Nó (1948) on nervous conduction in the absence of sodium suggested the trial of quaternary ammonium salts on intestinal function under such conditions. *Tetraethylammonium bromide and iodide* were found in small doses ($1:10^4$ to $1:10^3$) to cause inhibition, and in larger doses ($1:9\times10^2$ to $1:3\times10^2$) to result in equally obvious stimulation of peristalsis, with a rise in the circular tone of rabbit terminal ileum. This was seen in Tyrode solution with half-normal sodium chloride content (Fig. 9a) as well as in normal Tyrode solution (Fig. 9b). A similar stimulant effect was observed when *furmethide* (furfuryl trimethylammonium iodide) was added to the organ

bath in concentrations of about $1:10^6$, in the presence of half the normal sodium content. In Tyrode solution with no sodium, furmethide caused an increase in circular tone but no true peristalsis.

DISCUSSION

Normal peristalsis is a co-ordinated response of the intestinal musculature to a stimulus in the form of distention of the lumen. This response depends on the integrity of the nervous elements within the intestinal wall, since it can be abolished by the application of local anesthetics (e.g. cocaine) which, however, do not prevent the longitudinal "pendulum" movements (Feldberg and Lin, 1949). In view of the demonstration by Hodgkin and Katz (1949) that sodium ions are essential for conduction in nerves, it is, therefore, not surprising to find that these ions are equally necessary for normal intestinal peristalsis.

The results reported in this paper show that progressive reduction in the sodium chloride concentration of the surrounding medium has an increasingly depressant action on intestinal motility. It was observed that at a sodium chloride concentration sufficiently low to abolish the co-ordinated propulsive activity of the bowel, to-and-fro longitudinal movements were usually still present. These changes in length are probably less dependent than propulsive movements on a nervous mechanism, and for their complete abolition the sodium chloride concentration of the medium has to be reduced still further. In the same way the longitudinal contractions elicited by acetylcholine have been held to be due to a direct action on the smooth muscle fibers (Vogt, 1943; Feldberg and Lin, 1949), and in the experiments reported here, they were found to be still present, though reduced, at sodium chloride concentrations low enough to abolish the propulsive ability of the intestine, even in response to neostigmine stimulation (e.g. at 4 gm. NaCl/l. for rabbit intestine). In their study of the effects of reducing the electrolyte concentration on the longitudinal movements of rabbit jejunum, Magee and Reid (1927) described results comparable with those reported here. Their preparations

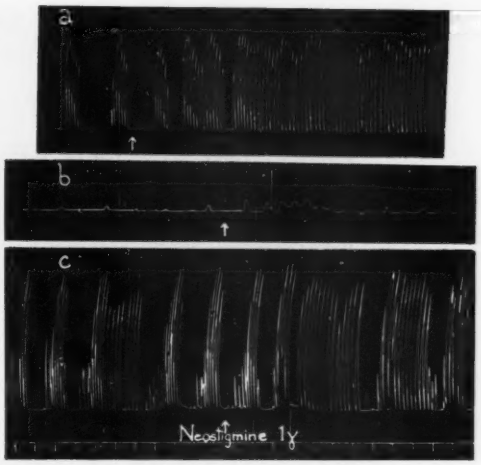

Fig. 7. Record of the volume changes of a Trendelenburg preparation of guinea pig terminal ileum, with the intraintestinal pressure maintained at 3 centimeters Tyrode. The gut was immersed in a and c in normal Tyrode solution, and in b, in a solution resembling in electrolyte content the plasma in a described case of paralytic ileus (Table I). Neostigmine, 1 microgram, was added to the 75 milliliter bath at each of the arrows. Time in minutes.

were even more sensitive to sodium chloride lack, and it was found that the sodium chloride concentration in the sodium chloride deficient Tyrode used had to be raised to 6 grams per liter before longitudinal contractions returned.

It is evident then, that if the sodium chloride concentration in the fluid surrounding the bowel is lowered below a certain critical level, peristalsis is abolished. This threshold sodium chloride concentration for peristalsis in sodium chloride deficient Tyrode solution was found to lie between 4 and 5 grams per liter for rabbit intestine and between 5 and 6 grams per liter for human bowel, which corresponds with a sodium concentration of 225 to 265 milligrams per cent and a chloride concentration of 327 to 389 milligrams per cent (or 539 to 641 mgm. per cent expressed as sodium chloride). This depression of peristalsis is in part the effect of hypotonicity since it is to some extent restored by bringing back the osmotic pressure to normal with dextrose or sucrose.

In the conditions which obtain in paralytic ileus, as exemplified by one of the cases of

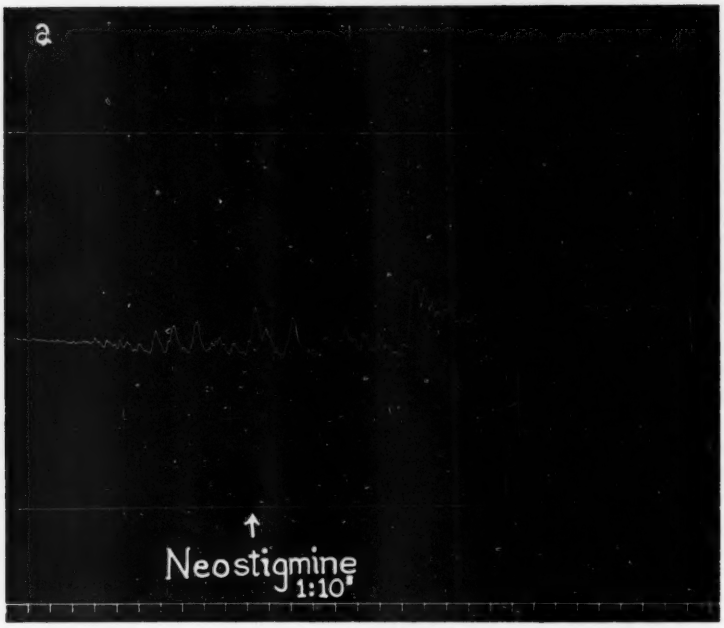

Fig. 8a (*Legend on opposite page*)

Falconer and others (1939), the plasma concentration of sodium is higher, and of chloride lower than at the threshold sodium chloride concentration, as determined here. Under these conditions, the experiments have shown that, while a certain amount of longitudinal activity is still possible, propulsive movements are abolished. Of the sodium salts used in this experiment, each separately had a stimulant action on peristalsis in low sodium chloride Tyrode solution, so that the impairment of contractility and of neostigmine response was due not to a specific inhibitory effect of any of the constituents, but presumably to the low chloride ion concentration (497 mgm. per cent, expressed as sodium chloride).

These experiments do not, of course, exclude the possibility that the bowel might react differently *in situ*, but it appears likely from this evidence that, in at least a certain proportion of cases of paralytic ileus, the intestine will remain unable to propel its contents unless the plasma deficiencies are made good. Such a conclusion would explain the experience described in the introduction to this paper, where a patient with paralytic ileus twice failed to respond to a neostigmine injection when in a state of sodium chloride depletion, and twice responded promptly with a bowel motion when the sodium chloride depletion had been overcome. The obvious conclusion is that parasympathomimetic drugs should have no place in the therapy of ileus until the sodium chloride deficiency has been rectified. Even then, there is no assurance that a cure will result unless the recurrence of sodium chloride depletion can be avoided. Perhaps the inactivity of neostigmine in the presence of chloride depletion would explain why the use of this drug for paralytic ileus has been abandoned by many modern surgeons (Devine, 1940; Wangensteen, 1942; Mason and Zintel, 1946; Pfeiffer, 1947; Aird, 1948).

From the evidence presented it seems likely that some cases of paralytic ileus are due to lowering of the plasma chloride concentration. The administration of sodium chloride in large amounts will not necessarily cure the condition, however, as is obvious from the

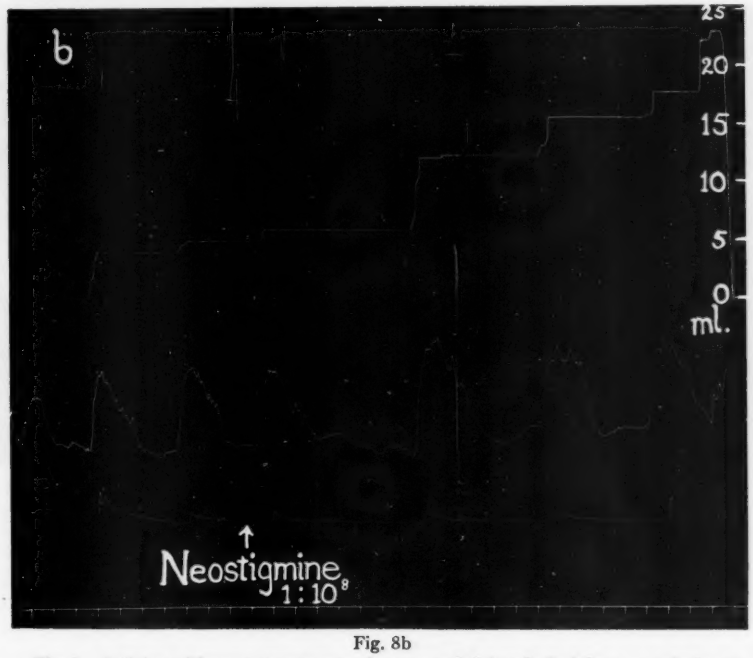

Fig. 8b

Fig. 8. Activity of human transverse colon suspended (method 2) in a, a solution resembling in electrolyte composition the plasma in a described case of paralytic ileus (Table I) and, b, normal Tyrode solution. The top tracing records the volume of fluid expelled from the intestinal segment, and is calibrated in milliliters. The middle tracing represents longitudinal contractions which are seen to be relatively little affected by the ionic deficiencies present in a, while the lowest tracing shows the peristaltic waves, present only in normal Tyrode solution. Neostigmine ($1:10^8$) was added to the bath at the arrows and resulted in stimulation of longitudinal contractions only, in a, and in an increase in the rate of outflow from 0.4 to 0.9 milliliter per minute in b. Time in minutes.

case history described. While the return of peristalsis appears invariably to follow upon the restoration of the normal plasma chloride level and urinary chloride excretion, the fact that a relapse may occur if intravenous saline therapy is stopped too soon indicates some failure of the normal mechanism controlling electrolyte distribution in the body. A study of some factors which may be concerned in this phenomenon is in progress.

It is impossible to determine the exact extent of sodium and chloride deficiency in severely depleted patients. In paralytic ileus there is a remarkably high tolerance for sodium chloride, and patients with ileus will frequently show obvious clinical improvement and no edema after the intravenous administration of more than 50 or even 70 grams of sodium chloride in 24 hours. In view of the danger of pulmonary edema and congestive cardiac failure, however, it is unwise to administer such large amounts of intravenous saline, and a safer policy is to follow the clinical rule of Bartlett, Bingham, and Pedersen (1938) and to give intravenously in the first 24 hours of treatment 0.5 gram sodium chloride per kilogram body weight for every 100 milligrams per cent of the plasma chloride reduction below 560 milligrams per cent (expressed as sodium chloride). Thereafter, unless the plasma chloride level remains low, it is useful to base the sodium chloride intake on the chloride loss through intestinal suction and in the urine over the previous 24 hours, with due allowance for loss in the sweat. The Fantus (1936) test can be used as readily to

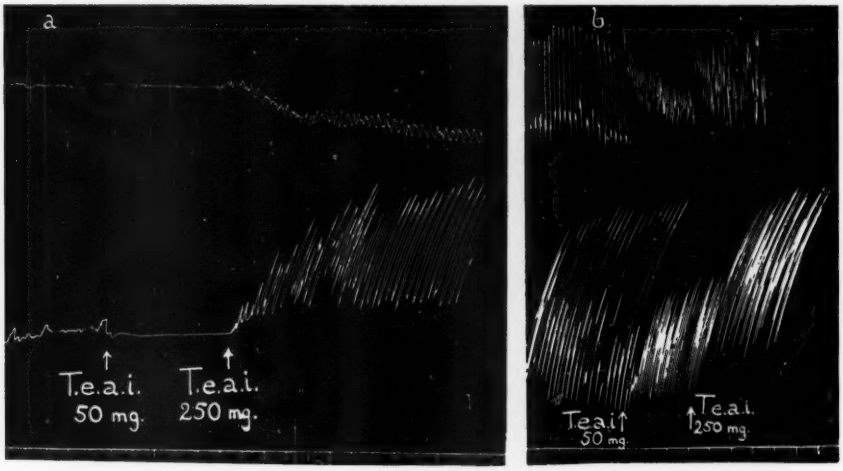

Fig. 9. Longitudinal (upper tracing) and volume (lower tracing) contractions of a strip of rabbit terminal ileum at a constant internal pressure of 3 centimeters in, a, Tyrode solution containing half the normal sodium chloride concentration, and, b, normal Tyrode solution. Tetraethylammonium iodide, added to the bath as indicated, is observed to cause inhibition of longitudinal and circular muscle activity in a concentration of 50 milligrams per 75 milliliters, and stimulation of the tone and amplitude of circular muscle contractions when a further 250 milligrams were added to the bath in low sodium chloride and normal Tyrode solution. Time in minutes.

determine the chloride concentration of aspirated intestinal contents as of the urine. It is advantageous to supply the body's need of other electrolytes and of protein by administering some of the required sodium chloride in the form of plasma or in Ringer and amino acid solutions.

The results obtained on the effects of sodium chloride deficiency on bowel motility are compatible with the findings of Orent-Keiles, Robinson, and McCollum (1937) obtained on rats fed on diets containing only 0.002 per cent of sodium but adequate amounts of other essential dietary constituents. Postmortem examination of these rats revealed the stomach and intestine to be "filled with gas," suggesting severe antemortem impairment of gastrointestinal motility.

The raised blood urea observed in paralytic ileus (Tileston and Comfort, 1914; Louria, 1921; Bick and Wood, 1941) is probably of no direct importance in the etiology of the condition since urea in high concentrations (up to 530 mgm. per cent) stimulates more often than it inhibits an isolated preparation of intestine.

It has been shown (de Nó, 1948) that quaternary ammonium ions having at least 3 ethyl radicals are able to substitute for sodium in nervous function. The fact that tetraethyl ammonium salts and furmethide can restore intestinal motility in the presence of severe sodium chloride deficiency supports the hypothesis that it is the nervous elements which are most adversely affected by such shortages of sodium chloride. This is of theoretical interest only, because tetraethyl ammonium salts inhibit peristalsis in small doses, and in all the studies which have been made of their effect on human gastrointestinal function, a depressant action has been observed (Zweig, Steigmann, and Meyer, 1948; Posey, Brown, and Bargen, 1948; Chapman, Stanbury, and Jones, 1948). In spite of the stimulant action of furmethide in vitro and its cathartic action in dogs and rhesus monkeys (12) it would be of doubtful value to use this drug in ileus, without first correcting the electrolyte deficiencies.

SUMMARY

It has been observed that a severe reduction in urinary and plasma chloride concen-

tration occurs in paralytic ileus and that under these circumstances neostigmine (prostigmin) injections are without effect. When the electrolyte disturbances have been corrected the bowel regains its contractility and responds promptly to neostigmine.

This observation prompted an in vitro investigation of the spontaneous contractions and the response to various drugs (physostigmine, neostigmine, acetylcholine, urea, and certain quaternary ammonium salts) of rabbit, guinea pig, and human intestine immersed in Tyrode solution containing varying degrees of sodium chloride deficiency. The methods employed were that of Trendelenburg (1917) and two modifications thereof, introduced in an attempt to estimate the propulsive efficiency of an intestinal segment by measuring the rate at which fluid was expelled from its lumen.

The results indicate that the propulsive power and the response to neostigmine and acetylcholine of isolated pieces of intestine are considerably impaired by a reduction in the sodium and chloride ion concentrations of the medium. That this is not entirely an osmotic effect is proved by the persistence of the impairment when a nonelectrolyte, such as dextrose or sucrose, is added in an amount sufficient to restore to the medium its normal tonicity. The presence of a certain concentration of chloride ions is as important as is that of an appropriate concentration of sodium ions, as has been proved by replacing sodium chloride with various sodium salts and chlorides.

The critical sodium chloride concentration below which no intestinal activity occurs spontaneously or in response to physostigmine and neostigmine appears to lie between 4 and 5 grams per liter for rabbit and between 5 and 6 grams per liter for human intestine. As in the case of peripheral nerves, so also in rabbit small intestine, certain quaternary ammonium salts (tetraethyl and furfuryl trimethyl salts) are able to replace sodium ions. Urea stimulates more frequently than it inhibits peristalsis of rabbit intestine in vitro.

The practical application of this work comes from the demonstration that, in a medium resembling in ionic composition the plasma in a case of paralytic ileus, the spontaneous peristalsis and response to neostigmine are much reduced in guinea pig and rabbit small intestine, and in human terminal ileum, cecum, and colon. It follows that the correction of the plasma electrolyte deficiencies by appropriate saline therapy should take priority in treatment before the administration of parasympathomimetic drugs in paralytic ileus.

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COLOSTOMY, INDICATIONS, TECHNIQUE, AND MANAGEMENT

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As one notes the voluminous accumulation of material on the single subject of colostomy and reviews the wide variety of techniques and the advantages supposedly inherent in each, he is led to inquire whether some simplification of this subject might not be in order. Our own experience is based upon approximately 500 operations of this type. Only three basic techniques have been employed for which no originality is claimed. With accumulating experience, however, certain personal modifications have inevitably been added. Three simple types of colostomy have so adequately fulfilled all of our needs in this regard that it seemed worth while to present a review of them and their management.

A colostomy as here defined is a procedure designed to divert the fecal stream to the outside of the body by the formation of an artificial opening into the colon. It may be intended for temporary or permanent use. It may be performed as an emergency procedure following trauma or mechanical obstruction of the distal bowel or as an elective procedure preliminary to or coincident with operations on the distal colon, sigmoid, or rectum.

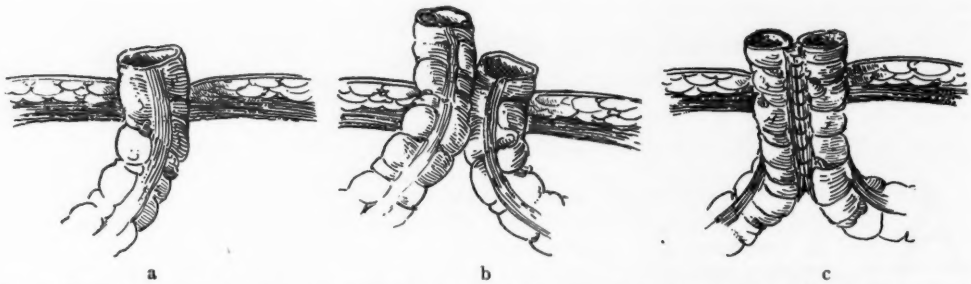
The following circumstances usually in association with carcinoma may result in, or indicate the performance of a colostomy: resection of the rectum, obstruction in any segment of the distal colon or rectum to the point where preliminary surgical decompression is necessary, following colon resection of the modified Mikulicz type planned so that colonic continuity may subsequently be re-established, and as a complementary elective procedure planned to temporarily divert the fecal stream to protect a distal suture line. Nonmalignant conditions which may necessitate some type of colostomy include the following: diverticulitis, regional or segmental colitis, injury to the colon or its blood supply, lymphogranuloma venereum, endometriosis, pelvic granulomatous fibroplastic conditions, and intravisceral colonic fistula (e.g. vesicocolic).

TYPES OF COLOSTOMY

The three types of colostomy used by us are diagrammatically shown in Figure 1, and will be discussed in the following order: end or single barrel colostomy, double barrel colostomy, and the loop colostomy.

End colostomy. Single barrel colostomies are usually performed on the left side or in the midline bringing the lower end of the descending colon or the sigmoid colon out as the artificial anus. This type of colostomy implies that some type of resection of the distal large bowel has been performed and it is therefore permanent. The most common resection resulting in an end colostomy is the Miles resection. An end colostomy may be necessitated after anterior rectal resection (Hartmann procedure), but this operation is now rarely used.

The proximal end of the colon can be brought out of the primary wound, which is usually either a left lower rectus abdominis muscle splitting or midline incision or through a separate muscle splitting incision. We prefer to bring the colostomy out through the original wound since the incidence of pericolostomy herniation in separate stab muscle splitting incisions has been high in our experience (5). Our procedure has been to close the wound snugly, but not tightly, about the bowel so that one finger can be inserted easily along the side of the bowel. The bowel must be delivered without tension. We do not suture the bowel or its appendages to the abdominal wound. Instead the colonic end is maintained in position by a clamp across the cut end supported just proximal by a circularly wrapped gauze sponge after the wound has been closed. This sponge is left in place for 7 days after which time adherence of the bowel to the wound has taken place and the gauze is removed.



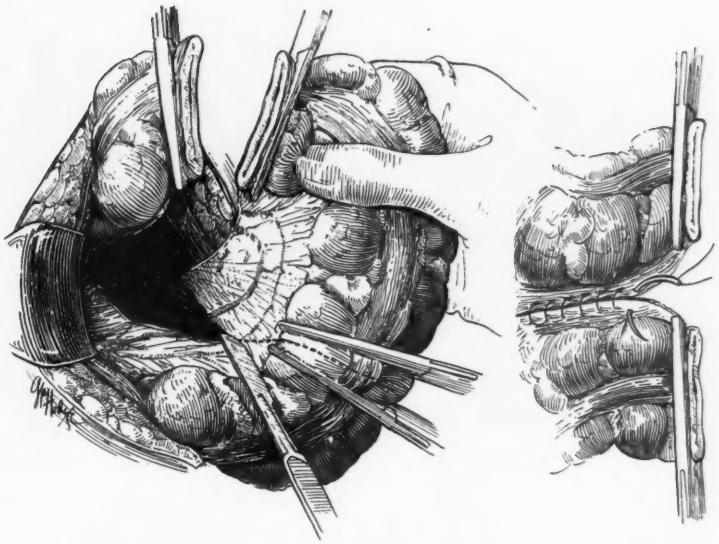
a b c

Fig. 1. Types of colostomy in cross section: a, end or single barrel colostomy; b, loop colostomy; c, double barrel colostomy.

In obese patients it is frequently desirable to "umbilicate" the skin about the colostomy as described by Cattell. This is performed by suturing the fascia to the undersurface of the skin, obliterating the fatty layer of the abdominal wall so that it is not in contact with the protruding bowel. Usually two sutures are necessary on each side and one at each end. This procedure makes the colostomy very inconspicuous and finds its greatest usefulness where there is insufficient bowel to traverse an obese abdominal wall without freeing the splenic flexure.

Double barrel colostomy. Double barrel colostomy can be performed in any segment of the colon on either the right or left side. It is a temporary outlet and is always planned for subsequent closure. This type of colostomy is most useful where a resection has been done at the site of the intended colostomy or at some distal point with immediate anastomosis. Its advantage is that subsequently it affords a more certain closure. It is not usually a suitable procedure if obstruction is present, since more manipulation is required in its construction than with a loop colostomy. Double barrel colostomy is most useful when a colonic resection has been accomplished, but when for one or another reason it is not deemed advisable to accomplish a primary anastomosis. It may also be performed preliminary to, or coincidental with resection and anastomosis of more distally situated colon.

In those cases in which it is done at the site of resection for carcinomas a large V of mesentery containing the last accessible lymph node is removed with the extirpated bowel. The cut edges of the excised mesentery are first apposed with a continuous or interrupted suture (Fig. 2). The proximal and distal segments of the bowel which have been cut are then brought together in parallel apposition. It is important that this apposition be accomplished without tension. This may occasionally necessitate mobilization of one or both of the colon flexures (hepatic or splenic). These two limbs of bowel are then sutured together along the adjacent free longitudinal bands (Fig. 3). The bowel is then rotated so that the next pair of tenia can be similarly sutured (Fig. 3b). This forms a septum between the two limbs of the bowel. It is important to make this septal spur at least 10 centimeters long. A long septal spur allows the crushing of an adequate length of bowel, making subsequent closure of the colostomy much easier. Too long a spur may result in the formation of a sac-like structure into which portions of the fecal stream will accumulate with the formation of a large mass of inspissated feces. This has occurred in 1 of our patients. The two limbs of the bowel, with the clamps still closing the cut ends, are brought out of the abdominal wound and the wound is closed with stainless steel wire. One should be able to insert the index finger snugly along the side of the two limbs of bowel after the peritoneum, muscle layer and fascia have been apposed. The subcutaneous tissue and skin are closed and a teased out gauze sponge is wrapped loosely around the protruding bowel below the two clamps. If a slight degree of obstruction is present, the clamp on the proximal limb of the bowel is loosened after the dressing has been applied, and a large catheter or small colon tube is placed in the lumen and the



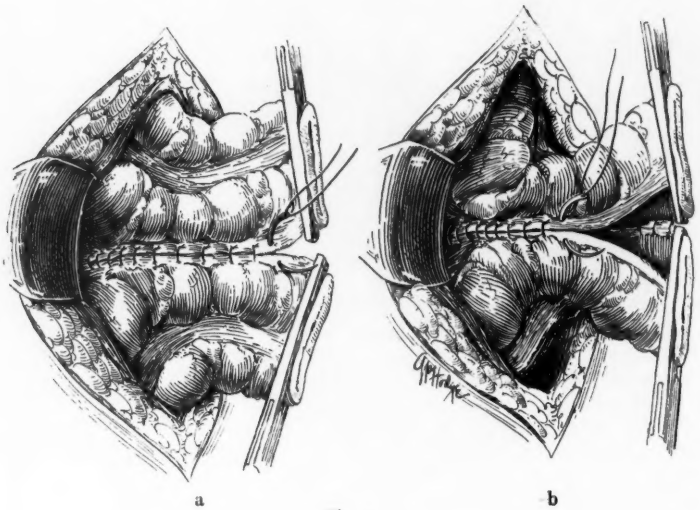
a b

Fig. 2. First stage in performing a double barrel colostomy. a, Diagram showing removal of V of mesentery with the extirpated bowel. b, Apposition of cut edges of mesentery.

clamp reapplied so that it holds the catheter snugly in place (Fig. 4). If there is no obstruction present the catheter is placed in the functioning colon stoma about 24 hours later to allow for the escape of gas. This interval has been chosen because of the hypotonia which usually lasts from 24 to 36 hours following intestinal manipulation.

When a double barrel colostomy is used as a preliminary procedure in preparation for future surgery or as a complementary procedure to protect a distal suture line, it is only necessary to free the desired length of large intestine and to appose the segments of adjacent bowel along two of the adjacent longitudinal bands as described previously. The wound is closed and the protruding loop of bowel is then cut transversely in order to parallel the blood supply and a catheter is inserted as described. The clamps on the cut ends of the bowel are removed on the third day. At the end of approximately 1 week the loop of bowel can be cut all the way across with the actual cautery if it has not been cut at the time of operation. As the edema and infection about the carcinoma in the now defunctionated distal bowel subsides, a previously complete obstruction may become incomplete and the distal colon and rectum can then be irrigated as a through-and-through procedure. This assists in more adequate preparation of the distal segment of the bowel for definitive treatment.

At the end of approximately the first week the septal spur between the loops of the double barrel colostomy can be crushed to establish bowel continuity. When resection and anastomosis of a distally situated tumor are coincidentally accomplished, or when this is subsequently intended, the spur is allowed to remain until restoration of the continuity of the fecal stream is desired. There are a number of specially designed clamps on the market for crushing colostomy spurs. We have not found it necessary to use any of these but simply apply a straight Kelly clamp. The lumens in the two limbs of the colostomy are palpated and the spur identified by placing one finger in each. The Kelly clamp is then opened and one blade is passed down alongside each finger until the clamp has engaged the septal spur throughout the length of each blade. It is then closed tightly (Fig. 5). The advantage of the



a b

Fig. 3

Fig. 4

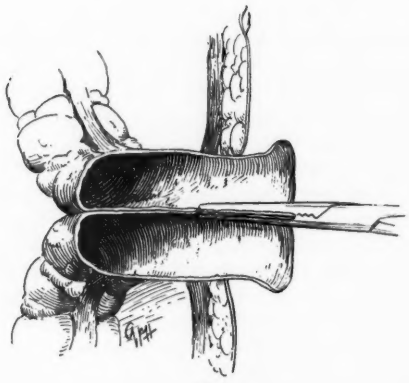


Fig. 5

Fig. 3. Formation of double barrel colostomy, the septal spur: a, apposition of first row of tenia coli; b, suturing of second row of tenia coli. The spur should be 12 to 14 centimeters long.

Fig. 4. Method of maintaining colostomy in position with clamps and gauze sponge. Also shown is the catheter in place to allow escape of gas and liquid stool.

Fig. 5. Crushing of colostomy spur: diagrammatic cross section illustrating the initial clamping of the spur in double barrel colostomy. When the clamp has cut through, it is reapplied further down on the septum until the spur is completely severed.

septal spur becomes apparent at this time as the clamp has a definite septum to crush instead of two adjacent but questionably adherent walls of bowel. The possibility of one blade of the clamp crushing other structures or eroding into the peritoneal cavity is eliminated. The clamp will usually come away without opening and can be easily lifted out

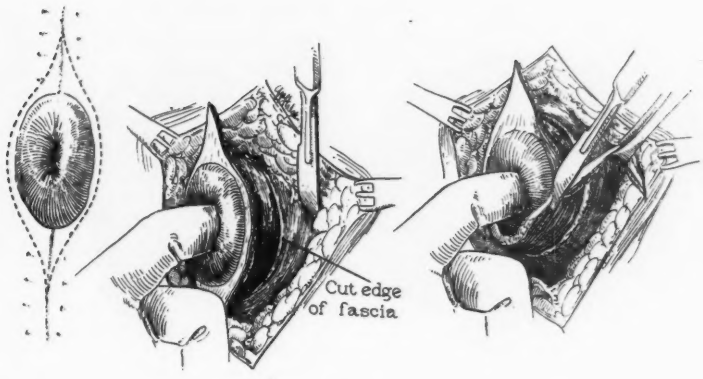


Fig. 6

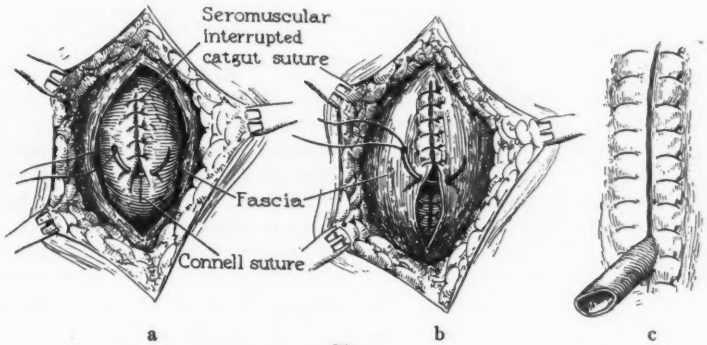


Fig. 7

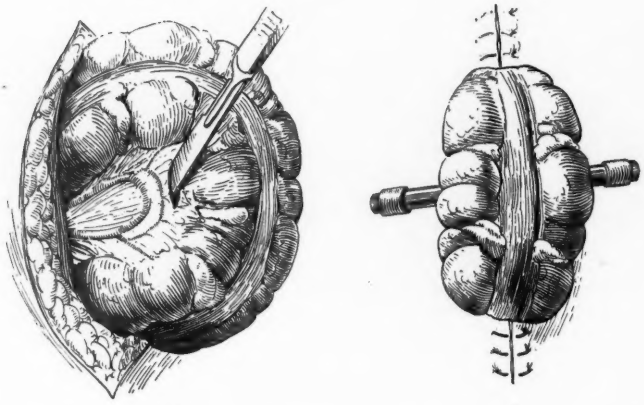
Fig. 6. Closure of double barrel colostomy: a, incision; b, exposure of fascia and muscle; c, removal of indurated fat, scar, and skin from bowel.

Fig. 7. Closure of double barrel colostomy (cont.): a, closure of bowel, a Connell suture and reinforcement by interrupted sutures of catgut; b, closure of fascia over inverted bowel; c, skin closure.

on the third to the fifth day after application. Two or occasionally 3 applications of the clamp will crush the entire length of the spur. This can be done while the patient is convalescing from the first operation. An ordinary tin can, with both ends removed, placed over the protruding end of the Kelly clamp and taped in position to the skin maintains it in the upright position. Crushing of the spur will usually result in restoration of the normal course of the fecal stream as soon as the edema in the bowel wall has subsided with only small and occasional spillage from the stoma. This markedly diminishes the inconvenience of the waiting period.

Patients who are to have the bowel continuity re-established are sent home for 6 weeks with instructions in colostomy care. Attempts to close the colostomy before this period frequently result in failure because of the induration and friability of the tissues. Success will be increased as tissue flexibility approaches normal.

The proximal and distal segments of the bowel are irrigated the evening before closure. Under appropriate anesthesia (we prefer continuous spinal) an elliptical incision is made about the colostomy stoma (Fig. 6 a). This incision is carried down to the fascia (Fig. 6 b). This structure is incised and the muscle sepa-



a b

Fig. 8. Construction of loop colostomy: a, bowel drawn into the wound and opening made in mesentery; b, closure of wound with rubber tipped glass rod holding the loop in position.

rated from the intestinal tube. One finger is placed in the colostomy stoma and the fatty areolar tissue adherent to the bowel is removed by sharp and blunt dissection (Fig. 6 c). Lahey has correctly pointed out that success in closure of these colostomies depends on how thoroughly one can remove the indurated fat and fascia from the colostomy. If the bowel is inverted while indurated tabs of epiploic appendages or scar tissue are attached, inversion is difficult and may result in postoperative eversion and leakage at the intestinal suture line. The intestinal tube should be as pliable as normal bowel for satisfactory and accurate inversion suture to be effective. The presence of one finger within the bowel lumen acts as a guide in excising the indurated tissue adherent to the bowel.

The lumen is next closed with a fine catgut suture by the Connell technique. A second row of interrupted catgut sutures is then employed to invert the bowel further (Fig. 7 a). Usually the closed end of the bowel drops of its own accord below the level of the posterior rectus sheath. The fascia is then apposed with interrupted moderate weight catgut (o chromic) (Fig. 7 b), a small rubber dam drain is placed in the wound and the subcutaneous tissue and skin are closed (Fig. 7 c). In spite of the obvious contamination of these wounds, only rarely does visible wound infection occur or more rarely a small temporary fecal fistula may develop. We have not found it necessary to resort to the laying of antiseptic soaked sponges in the wound beneath sutures placed for delayed closure. In our experience these have all closed without incident. The resultant abdominal wall should be as firm as following any abdominal wound closure. About 1 week of hospitalization is usually required.

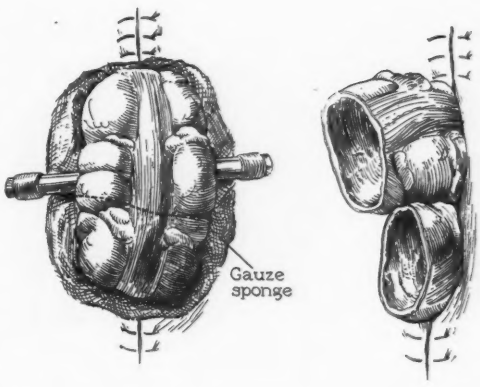
Loop colostomy. This type of colostomy is usually performed for the relief of obstruction in the descending colon, sigmoid, or rectum. Loop colostomy is usually performed on the transverse colon or the sigmoid colon and may be intended for permanent or temporary use. In the face of obstruction the loop type of colostomy takes precedence over the double barrel colostomy as it is the least traumatic, consumes less time, and is the least disturbing to the patient. The simplest least traumatic type of procedure which will relieve obstruction is always preferable. It is a well proved dictum of colon surgery that resection should never be carried out in the face of obstruction.

Loop colostomy may be the only procedure possible for an inoperable malignant lesion of the distal large bowel. It may also be carried out preliminary to subsequent perineal resection of the rectum. At other times it serves to divert the fecal stream for contemplated or coincidental resection and anastomosis distal

to the colostomy. This procedure may at times be utilized in the treatment of nonmalignant conditions such as diverticulitis, lymphogranuloma, ulcerative colitis, traumatic lesions, etc.

As mentioned previously, loop colostomy is usually performed in one of the redundant segments of the colon, transverse colon, or sigmoid. One should bear in mind that it must not be placed at a point where it might interfere with a subsequent bowel resection. When the loop colostomy is intended to be permanent, as in inoperable carcinoma, it should be placed as far distal in the colon as is technically possible. It must be remembered that the function of the colon is to remove water from the waste entering it and that therefore better formed, less frequent, and less bulky stools will be obtained distally.

As in all colostomies enough bowel must be mobilized to allow exteriorization without tension and allow at least 2.5 centimeters of bowel protruding above the skin after the loop has been divided. We have noted, as was previously mentioned, less wound weakness and a lower incidence of herniation about colostomies which have been brought out of the original wound instead of through a stab or muscle splitting incision lateral to the rectus muscle (5). Moreover, the incidence of pericolostomy hernia is more common after loop colostomy than after other types. This is apparently due to atrophy of the distal bowel resulting in disproportion between the colostomy and the abdominal wall opening. In transverse colon loop colostomy we prefer to bring the bowel out through a high right rectus muscle splitting wound. This avoids complicating the later intended resection on the left colon. In sigmoid loop colostomy a lower left rectus muscle splitting incision is used, and the bowel is brought out through the incision. In the absence of obstruction we prefer continuous spinal anesthesia and an incision permitting thorough abdominal exploration. In the face of obstruction sufficient to contraindicate exploration a loop colostomy can be easily performed under local anesthesia with a minimum of disturbance to the patient and with an incision adequate only to permit easy delivery of the bowel loop.



a b

Fig. 9. a, Demonstrates teased out sponge used in all colostomies to hold bowel in position. Dotted line indicates the site at which the bowel is to be severed; b, loop of bowel cut across after the wound is healed.

Transverse loop colostomy is performed by drawing the transverse colon into the wound (Fig. 8a), removing the omentum from a short segment, and inserting a glass rod (a catgut tube is satisfactory) through the mesocolon adjacent to the bowel. Each end of the glass tube is covered with a short segment of rubber tubing after it is in position (Fig. 8b). The rubber sleeves prevent the glass rod from slipping from under the loop of bowel. The wound is then closed with stainless steel wire and the skin and subcutaneous tissues apposed with cotton sutures. A teased out gauze sponge is loosely wrapped about the loop of bowel below the glass tube (Fig. 9a). No attempt is made to suture the bowel to the wound edges. In obese patients it is frequently desirable to "umbilicate" the skin about the colostomy in the manner previously described with end colostomies.

In performing a sigmoid loop colostomy as a preliminary to subsequent perineal resection of the rectum, all damage to a marginal artery, usually present, should be carefully avoided. If this caution is not observed the later damage to the sigmoidal vessels when the inferior mesenteric stalk is transected may result in necrosis of some of the distal segment of bowel below the abdominal wall. We have had this occur in 1 case without mortality but with considerable morbidity.

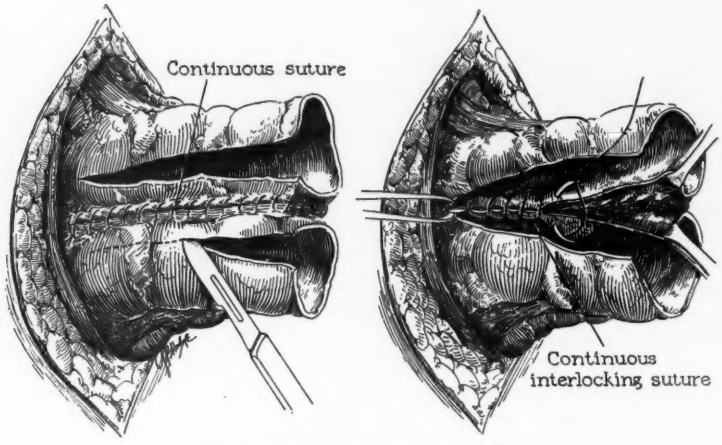


Fig. 10. Pauchet type of closure of double barrel colostomy: the bowel has been freed and all fat and scar tissue removed. a, Shows the seromuscular suture and the adjacent limbs of the bowel opened; b, demonstrates the apposition of the cut edges of the bowel.

Not too infrequently one still encounters an easily operable lesion usually in the rectum which for one reason or another had been considered inoperable by some other surgeon with the performance usually of a loop colostomy. Formerly, in an attempt to minimize contamination, the abdomen was re-entered through a separate incision and in the course of the removal the stump of the distal loop was turned in. After one of these short distal stumps had sloughed with subsequent obstruction of an ileal loop at the point of slough we discontinued this practice. We prefer now to excise the already fashioned loop colostomy with resection and establishment of the usual end colostomy.

If obstruction is present, a purse-string suture is laid at the junction of the middle and distal thirds of the loop, a 0.5 to 1 centimeter transverse incision is made and a large catheter or small rectal tube is inserted and held in place with the purse-string suture. It is important to use a large catheter if immediate decompression is indicated. When obstruction has been present for some time the bowel is filled with semiliquid stool although this may appear to be gas, hence the need for a large tube. Irrigation of the colon can be carried out while the patient is on the operating table through this tube after the dressing is in place with little fear of wound contamination. If obstruction is not present the catheter is inserted at the end of 24 hours without disturbing the gauze wrapped about the loop. No purse-string suture is necessary after this delay as fecal spillage will not infect the wound by this time.

A loop colostomy should always be opened in a transverse direction. Since this incision will then parallel the segmental blood supply there is usually no bleeding. It is done with a scalpel and not with a cautery. It also makes for easy subsequent closure without diminishing the caliber of the lumen.

The loop is completely divided in 7 to 10 days depending on the rate of healing. If infection is present the glass tube can be left in place to prevent retraction of the loop until the wound has completely healed. The bowel is severed with the actual cautery at the junction of the middle and distal thirds of the loop of protruding bowel (Fig. 9b). The proximal end usually protrudes 2.5 to 3 centimeters above the skin and the distal end 1.5 centimeters. After shrinkage the distal and nonfunctioning end will be at the skin level.

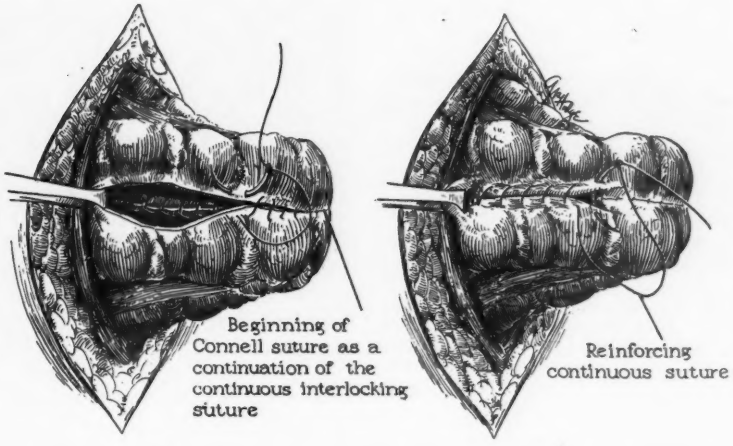


Fig. 11. Pauchet type of closure of double barrel colostomy (cont.): a, continuation of the mucosal stitch as a Connell suture; b, anterior seromuscular suture completes the anastomosis.

PREOPERATIVE MANAGEMENT IN THE PRESENCE OF INTESTINAL OBSTRUCTION

This will vary with the indication for the operation. In the presence of complete obstruction a scout film of the abdomen should be taken. Barium should never be given by mouth if intestinal obstruction is suspected. A barium enema is usually indicated as it will locate the point of colonic obstruction and guide the surgeon in selecting the proper site for the colostomy with a view to future definitive operative procedures as well as immediate relief of the obstruction. We recently had an elderly patient with obvious intestinal obstruction and a mass in the epigastric region whose barium enema showed no obstruction in the colon but a definite carcinoma in the midportion of the transverse colon. Several loops of dilated small bowel were observed on the film and it was obvious that the obstruction was not in the colon and more probably in the small intestine. This proved to be true. At exploration a loop of small bowel was invaded and obstructed by the carcinoma arising in the transverse colon. If a cecostomy had been planned without the preliminary x-ray studies the patient's obstruction obviously would not have been relieved. A Levine tube is passed to empty the stomach in all such cases. At times if active peristalsis is still present a Miller-Abbott tube can be passed and if it enters the small bowel, operation may occasionally be delayed. In the absence of peristaltic activity as from prolonged distention with overstretching of the muscularis or with marked peritoneal irritation, our success with this tube has been unsatisfactory. It must also be remembered that if the ileocecal valve is competent gas and liquid can pass into the colon and be trapped there even when a decompressing tube has passed into the small intestine. When colonic obstruction has occurred relatively suddenly as from inflammatory lesions or a volvulus the colon contents will consist largely of gas. When carcinoma is present, however, the luminal narrowing takes place slowly and progressively with gas the last form of matter to make its escape. Under these circumstances the colon is usually filled with liquid or soft stool with little gas present. We do not believe that more than 12 to 24 hours should be lost in this form of conservative treatment in most cases. Dehydration and anemia should be corrected before operation if possible. A word of warning about excessive exploration or trauma in the face of acute intestinal obstruction should be sounded. These patients should be handled gently and

TABLE I.—INSTRUCTIONS FOR COLOSTOMY CARE

(Given to all permanent colostomy patients)

Equipment to be used for colostomy care:

1. Hot water bottle with tubing, or enema can with tubing, but preferably a used liter flask (1 quart) with intravenous tubing and Murphy drip.
2. Small glass connecting tip.
3. Male urethral catheter, size No. 18 F.
4. Hygeia nipple.
5. Jar of white vaseline.
6. One large pan or wash basin.

Instructions to patient for colostomy management:

1. Take an irrigation every other morning or evening (not every day). A regular time should be chosen.
2. One quart of tap water, quite warm, but not hot to your hand.
3. Hang bottle (enema bag or can) so that it is not more than 12 to 15 inches above the colostomy opening.
4. Lubricate end of catheter with vaseline and insert it slowly for 6 to 8 inches into the colostomy.
5. When water has all run in, remove catheter.
6. Allow at least 30 minutes for water and stool to be expelled.
7. The best results will be obtained if the irrigation is taken lying down but if this is impossible you may take it sitting up. You may sit up while it is being expelled, catching the stool and water in the wash basin held snugly below the colostomy.
8. Keep the colostomy well opened by gently inserting the well lubricated middle finger of the right hand past the second joint once each week after the irrigation. (Rubber finger cots can be obtained at most drug stores for this purpose.)
9. Avoid all foods which previously produced diarrhea (certain raw fruits, beans, etc. are common offenders).
10. Take no laxatives.
11. Wear an abdominal support or band with a square of clean washed linen over the opening, nothing else. (A ladies' 2-way-stretch girdle of appropriate size with the garters removed is excellent.)
12. *Do not wear a colostomy bag.*
13. Perfect control should be attained after 2 to 4 months.

the surgeon must resist the urge to explore manually as the added trauma may mean the difference between life and death in the poor risk patient. This may frequently leave one in the uncomfortable position of facing a second laparotomy with the nature of the obstructing lesion still unknown and should it be a carcinoma with its resectability in doubt. Visible free fluid or peritoneal injection, of course, need not indicate peritoneal carcinomatosis but visible nodules or apparent implants usually do. It has been our practice to perform a biopsy on any of these that are readily accessible in order to avoid subsequent laparotomy in hopelessly advanced cases.

In elective colostomies the colon is prepared by saline catharsis and rectal irrigations, and if possible the nutrition is improved and anemia reduced. Succinylsulfathiazole is given for a period of 5 to 7 days before these elective operations. This drug tends to soften the stool and if partial obstruction is present it is the antibiotic of choice. Sulfathalidine is equally effective in its bacteriostatic action but the stool tends to remain more formed. It is our custom to administer streptomycin by mouth 36 to 48 hours before surgery. It must be remembered in using this drug that the colon organisms rapidly become resistant to it. The optimum reduction of the colonic bacterial flora occurs approximately 28 hours after the streptomycin is started (1). Poth has shown that less edema occurs and wound healing is more rapid in animals who have been prepared for colon surgery with succinylsulfathiazole.

Occasionally low grade infection may develop in the wound about the colostomy. This usually occurs in obese patients. The low resistance of fatty tissue to infection is so well known as hardly to require mention. The application of wet dressings to the colostomy and wound and the use of antibiotics will usually readily control these infections. Occasionally the removal of part of the skin stitches may be necessary to allow adequate drainage.

In the closure of loop colostomies we prefer a modified Pauchet type of closure. We have occasionally used this procedure with success in double barrel colostomies and it is our preference for the occasional loop colostomy that we close. It does necessitate the entering of the peritoneal cavity and the possibility of infection is increased. The technique of this closure is well shown in Figures 10 and 11.

Advantages of the double barrel colostomy are that:

1. It allows complete diversion of the fecal stream.
2. Immediate decompression of the bowel is possible.
3. Alignment of the alimentary tract can be easily re-established when desired.
4. It allows extraperitoneal closure.

Its primary disadvantages are that in the face of the more severe grades of obstruction it requires too much manipulation of the bowel and subsequently in order to establish closure a separate though minor operative procedure is necessary.

Stricture of colostomy: This almost always occurs at the skin-mucosal junction. Occasionally through retraction and scar formation about the colostomy, the opening may become so small that revision is necessary. This is a simple procedure and can be done in the office under local anesthesia. A circular incision is made around the colostomy and the narrow margin of scarred skin is excised from the bowel, leaving it flexible and thin. The edges of the bowel are then apposed to the surrounding skin by interrupted stitches of fine cotton. The patient is instructed to wear wet compresses over the stoma as this seems to reduce the incidence of infection. The stitches are removed on the eighth to tenth day after operation. Stricture formation is more common after previous wound infection. This can usually be prevented if patient will digitally dilate colostomy stoma with each irrigation.

Retraction of the colostomy stoma should not occur in properly performed colostomies and is more easily prevented than corrected. It is usually due to inadequate freeing up of the bowel with resultant extirpation under tension.

Prolapse of the colostomy: This complication takes place very rarely and is usually an intussusception of the proximal bowel through the colostomy stoma. If the protruding bowel is still patent and not gangrenous the operative correction is an elective procedure. In the operating room, under continuous spinal anesthesia, the protruding bowel is tied off to prevent fecal spillage during the operation. The colostomy is circumcised by an elliptical incision carried down into the peritoneal cavity and the segment of intussuscepted bowel is delivered to the outside. The fascial and muscular layers are closed with stainless steel wire and the skin is closed with cotton. A clamp is placed across the normal bowel 5 centimeters above the skin and a gauze sponge wrapped about the colostomy below the clamp. The bowel distal to the clamp is cut away. Prolapse of the colostomy is not as common as is the prolapse of ileostomies. It has occurred only once in over 500 colostomies.

MANAGEMENT OF THE COLOSTOMY PATIENT

When properly regulated a colostomy need not prevent normal activity or cause embarrassment. Much of the unfavorable reputation that an artificial anus has acquired is due to the palliative colostomy. The ulceration and infection of the tumor with the consequent irritation may maintain the bowel in a constant state of upset.

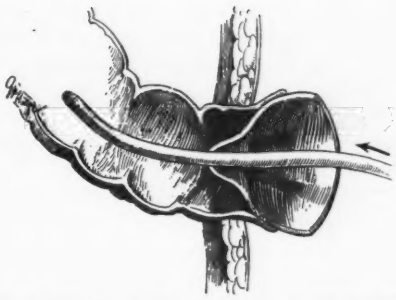


Fig. 12. Cross section demonstrating the use of a Hygeia nursing nipple to prevent regurgitation of irrigating fluid (see text).

In contrast, permanent colostomy following resection of the distal tumor may be managed with little effort and marked success after a brief adjustment period. Training in colostomy care is started while the patient is still in the hospital. The first few irrigations are performed by the attending nurse who explains the procedure to the patient. The patient then goes through the procedure under the nurses direction until he can perform the irrigation without aid. The equipment suggested is listed in Table I. This table also lists the instructions which are given to each patient. Individual variations from the routine must be patiently worked out. Emphasis is placed on making the patient self-sufficient and independent of outside help. Except in very ill patients even when such help is easily available we have discouraged its use. Too rapid flow, or water that is too cool, occasionally causes colonic spasm preventing complete filling and cleaning of the entire colon. The rate of flow can be visualized by placing a Murphy drip in the tubing. We have found that conventional intravenous set and a used liter fluid flash is an excellent substitute for the usual enema bag or can and is easily obtainable in any hospital. Occasionally regurgitation of irrigating fluid from the colostomy stoma is encountered. A simple method of

overcoming this is the use of a Hygeia nursing nipple with the end of the nipple cut so that a catheter can be passed snugly through it and then inserted into the colostomy stoma. The nipple is then inserted into the colostomy stoma and held firmly in place, preventing regurgitation of the enema water (Fig. 12). *A regular time should be chosen for the enema and plenty of time must be allowed for the water and stool to be expelled.*

We rarely find it necessary to prescribe constipating diets as patients quickly learn what foods cause them to have loose stools. In general, raw vegetables and fresh fruits can be expected to cause some trouble. During the period of colonic adjustment the patient is given prescriptions for paregoric and bismuth subcarbonate to be used if necessary. Patients will usually obtain almost perfect control within a period of 2 to 4 months.

Most patients will find that an irrigation every other day will prove satisfactory. Occasionally heavy eaters will require daily irrigations. Small or thin individuals who do little physical work and whose intake of food is low may not have to irrigate the colon except every third day. To prevent stricture of the colostomy it is essential that the patient dilate the stoma at least once a week. This is easily done by inserting the middle finger past the second joint after it has been well lubricated.

It is the surgeon's responsibility to help these patients maintain their confidence and morale. In patients who are having difficulty a detailed review of the method of colostomy management usually reveals some obvious fault which can be easily corrected by a few minutes of instruction. Patients in all walks of life may carry on their usual activities with only slight inconvenience.

SUMMARY

A colostomy may be defined as the diversion of the fecal stream to the outside of the body by the formation of an artificial opening into the colon. The circumstances indicating the performance of a colostomy have been outlined. The technique of performing and the subsequent management of end colostomy, double barrel colostomy, and loop colostomy are described and illustrated. The closure of double barrel colostomies is stressed. Finally our method of management of the colostomy patient is discussed.

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GASTROJEJUNOCOLIC FISTULAS

Postoperative Complications in Nineteen Cases

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GASTROJEJUNOCOLIC fistula, gastrocolic fistula, and jejunocolic fistula are serious complications which may follow posterior gastroenterostomy performed in the treatment of duodenal ulcer. These result in the same clinical picture, the etiology of which is an abnormal fistulous communication between the stomach and colon. The normal course of food and liquid in the intestinal tract is altered by passing through the fistulous tract from the stomach directly to the colon. Physiological processes are markedly altered. The digestion of food is inadequate; the gastric juices exert an irritating effect on the colon resulting in a pronounced diarrhea with the stools containing recognizable undigested food particles. A rapid nutritional deficiency results which renders the patient a poor operative risk and accounts for the high mortality in several reported series.

Prior to 1903 seventy cases of fistulas, of which all were secondary to cancer, were reported in the literature. The abnormal tract was the result of neoplasm primary in either the stomach or colon. Haller, in 1755, first reported such a case. Gastrojejunocolic fistulas following posterior and anterior gastroenterostomies were reported first by Czerny in 1893. These were demonstrated 12 years after the first anterior gastroenterostomy (performed by Wolfer, 1881) and 8 years after the earliest posterior gastroenterostomy (performed by von Hacker, 1885). By 1940, Thomas reported 207 cases of gastrojejunocolic fistulas following jejunal ulcers.

The age incidence is not characteristic in any of the reported series. Most cases develop after the age of 30 but occurrences have been reported in the second decade and as late as the eighth decade. Our series includes a youth who was 14 years old at the time of his death from a gastrojejunocolic fistula. This patient showed an extreme ulcer diathesis with a stormy ulcer history during his last 2 years of life.

More important is the sex of the patient, since in this series only 1 of the 19 cases (5.3 per cent) was a female. This conforms with all other reported series in which the incidence in females has been reported as either extremely low or nil.

Gastrojejunocolic fistulas may be divided on an etiological basis into: (1) those caused by cancer; (2) those caused by jejunal ulcer; and (3) those infrequent cases caused by tuberculosis, syphilis, or abscess. In this series no fistulas secondary to neoplasm were encountered nor were any seen arising as results of inflammatory processes of the stomach or colon. In this connection, it is of interest to note that no cases have been reported secondary to ulcerative colitis. From the above, it is seen that all cases reported in this series resulted as complications of jejunal ulcers. In this category, it is advisable to mention the relatively high incidence of jejunal ulcer following posterior gastroenterostomy as compared with the low incidence following anterior gastroenterostomy or gastric resection. The anatomical hook-up may play an important role in these cases.

We are reporting 19 cases of gastrojejunocolic fistulas of which 3 are described in some detail while the remaining 16 cases are abstracted in chart form (Table I).

PATHOLOGY

Pathologically, the jejunal ulcers productive of these fistulas are essentially the same as peptic ulcers. The edges are smooth and sharp. The craters ulcerate deeply with sur-

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TABLE I.—SYMPTOMS, SIGNS, AND OPERATIVE PROCEDURES UPON 16 PATIENTS WITH GASTROJEJUNOCOLIC FISTULA

No.	Patient	Age years	Sex	Presence of duod. ulcer	Type of primary operation	Duration of relief	Symptoms and signs of Fistula						X-ray visualization	Type of subsequent surgery	Final result
							Diarrhea	Wt. loss	Vomiting	Pain	Fetor oris	Bleeding			
1	L. G.	49	M	Yes	Postoperative gastroenterostomy	1 yr. 4 mo.	+	+	−	+	−	−	Barium enema, g.i. series	1. Dismantling operation 2. Subtot. gastrectomy	Asymptomatic
2	L. B.	63	M	Yes	Postoperative gastroenterostomy	5 mos.	+	slight	+	+	−	−	Barium enema	1. Dismantling operation 2. Subtot. gastrectomy	Asymptomatic
3	M. R.	65	M	Yes	Postoperative gastroenterostomy	5 yrs.	+	+	−	+	−	−	Barium enema	1. Dismantling operation with gastric resection	Asymptomatic
4	J. S.	37	M	Yes	Postoperative gastroenterostomy	4 yrs.	+	+	+	+	−	+	Barium enema	1. Dismantling operation 2. Subtot. gastrectomy	Asymptomatic
5	W. W.	41	M	Yes	Postoperative gastroenterostomy	4 yrs.	+	+	−	−	+	+	Barium enema	1. Dismantling operation with gastric resection	Asymptomatic
6	H. Z.	59	M	Yes	Gastroenterostomy, type undetermined	21 yrs.	+	+	+	+	−	+	Barium enema, g.i. series	1. Dismantling operation	No follow-up
7	J. M.	45	M	Yes	Postoperative gastroenterostomy	8 yrs.	+	−	+	−	+	−	Barium enema	1. Dismantling operation with gastric resection	No follow-up
8	R. I.	64	F	Yes	Postoperative gastroenterostomy	9 yrs.	+	+	−	−	−	−	Barium enema	1. Dismantling operation with gastric resection	No follow-up
9	W. D.	35	M	Yes	Postoperative gastroenterostomy	2 yrs.	+	+	−	−	−	−	Barium enema, g.i. series?	1. Dismantling operation 2. Gastric resection	Recurrent enterocolic fistula
10	A. G.	52	M	Yes	Postoperative gastroenterostomy	5 yrs.	+	+	−	−	−	−	Barium enema, g.i. series	1. Dismantling operation	Expired following g.i. hemorrhage
11	A. S.	47	M	Yes	Gastroenterostomy, type undetermined	11 yrs.	+	+	+	−	−	−	Barium enema, g.i. series	1. Dismantling operation	Postop. death
12	L. R.	50	M	Yes	Postoperative gastroenterostomy	3 yrs.	+	+	−	−	+	−	Barium enema	1. Dismantling operation	Expired following g.i. hemorrhage
13	R. J.	36	M	Yes	Gastroenterostomy, type undetermined	9 yrs.	+	+, −	−	−	+	−	Barium enema	1. Dismantling operation 2. Gastric resection	Postop. death
14	C. B.	63	M	Yes	Gastroenterostomy, type undetermined	4 yrs.	+	+	−	−	−	−	Barium enema, g.i. series	1. Dismantling operation with gastric resection	Asymptomatic
15	M. P.	45	M	Yes	Gastroenterostomy, type undetermined	2 yrs.	+	−	−	+	+	−	Barium enema	1. Dismantling operation	Postop. death
16	M. B.	70	M	Yes	Postoperative gastroenterostomy	2 yrs.	+	−	+	+	−	−	Barium enema, g.i. series	1. Dismantling operation 2. Subtot. gastrectomy	Asymptomatic

rounding inflammatory changes followed by the formation of dense adhesions to adjacent structures, particularly the colon. The inflammatory process eventually ulcerates through the wall of the colon. The fistulous tract is thus established, encased by dense adhesions rendering any operative procedure extremely difficult and often necessitating more extensive resection than is at first anticipated. A few cases have been reported in which the extent of adhesion formation was slight, thereby facilitating surgical intervention; such occurrences, unfortunately, are extremely rare.

The location of the fistula is reported as being most frequently at the site of anastomosis (gastrojejunal) with some ulceration of the adjacent gastric wall in occasional cases. The next most frequent location is in the distal or efferent loop of the jejunum, usually within 4 to 8 centimeters of the gastrojejunal stoma. It is rare to find a jejunal ulcer or fistula in the proximal (afferent) loop.

The presence of two fistulas occurring simultaneously was reported before 1925 by Haufmann and Gorsset. A search of the literature since that date fails to show a report of a similar occurrence. Cases have been described in which the fistulous tract and the jejunal ulcer were separated by a distance sufficient to indicate that the latter was not involved in the production of the fistula, but no such circumstance occurred in our series.

In this series several of these unusual circumstances were met. Out of the 19 cases of fistulas secondary to gastroenterostomy in which the site of the tract was determined, 14 fistulas (73.7 per cent) were at the site of gastrojejunal anastomosis; 3 tracts (15.8 per cent) were located in the distal (efferent) loop. In 1 case, the tract was found in the proximal loop at a distance of 6 centimeters from the stoma. Another case presented 2 entirely separate fistulous tracts, closely approximated one to the other. This patient was notable because 2 years previously he had had another gastrojejunocolic fistula dismantled at this hospital.

Fig. 1. M.P., Hospital No. 266–255, 65 year old male, had a posterior gastroenterostomy in May, 1940 during treatment of an active duodenal ulcer. He continued to have vomiting and pain postoperatively; roentgenograms showed poor function of the stoma (with a "circus movement" of the barium meal). At reoperation, and entero-enterostomy was performed resulting in complete relief of ulcer symptoms. However, in June of 1945, he experienced abdominal pain, severe diarrhea, and lost 20 pounds in weight. A gastrojejunocolic fistula was demonstrated by barium enema. Note filling of the stomach (*S*) during this examination. No filling of the colon proximal to the fistula was obtained. A very large marginal ulcer (arrow) is seen. A dismantling operation and gastric resection was followed by complete relief of symptoms.

DIAGNOSIS

As stated previously, the patient is usually a male with a well established history and symptomatology. The stage of the primary lesion is that in which symptoms due to the primary duodenal ulcer predominate. Because of intractable pain, bleeding, or other complications all these patients were subjected to surgery. This, in the greater percentage of cases, was a posterior gastroenterostomy. Out of the 19 cases in the present series, 14 had such a procedure; in 5 cases we were unable to determine the exact type of primary operation but undoubtedly most of these 5 had posterior gastroenterostomies since the primary operative procedures were done at a time during which posterior gastroenterostomies were more commonly performed.

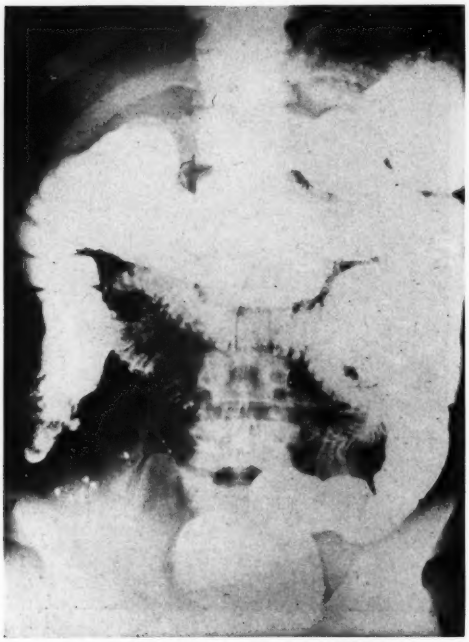


Fig. 2. W. W., Hospital No. 374–286, a 41 year old male, who had a posterior gastroenterostomy in 1937 as treatment of a duodenal ulcer. Symptomatic relief was obtained for a period of 4 years. In 1941 this patient developed easy fatigability, diarrhea, belching of fecal-like gas, and lost 10 pounds in weight. The fistulous tract was demonstrated by barium enema; very rapid filling of stomach and proximal jejunal loops was seen on fluoroscopic observation. The fistulous tract was also seen at fluoroscopy; it was located just proximal to the splenic flexure. A gastrointestinal series 2 days previously had shown a functioning gastroenterostomy and a defective duodenal bulb but no evidence of the fistulous tract. This patient obtained complete relief following a dismantling operation combined with subtotal gastrectomy.

It is important to note that every patient had undergone surgery; therefore, the formation of a fistulous tract may be actually considered a late complication of the surgical procedure.

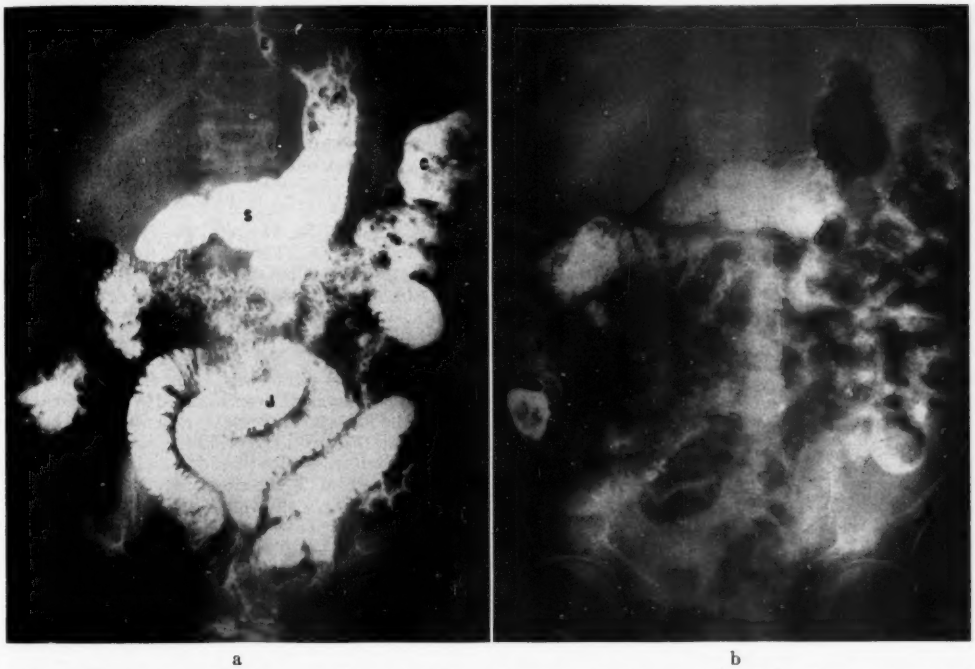
The postoperative stage may be divided into: (a) a period of relative freedom from symptoms which may vary in duration from a few months to many years, and (b) the second period consisting of occurrence of the complaints related to the presence of a jejunal ulcer. The symptoms of the jejunal ulcer are essentially different from those of the primary duodenal ulcer. There is a shift in the location of the ulcer pain to the left side of the abdomen in the region of the umbilicus. The discomfort is more irregular in occurrence. There is frequent hemorrhage which may be silent in nature. Six patients (approximately 30 per cent) in this series had frank hemorrhages from the gastrointestinal tract attributable to secondary jejunal ulcers. These ulcers respond more poorly to dietary and medical management.

The stage of the fistula is usually marked by the onset of diarrhea which is persistent and severe, frequently resulting in 12 to 15 stools per day. This is a striking manifestation which should immediately suggest the development of a gastrojejunocolic fistula in any patient having had a posterior gastroenterostomy performed in the treatment of duodenal ulcer. In the present series, diarrhea was a leading symptom in every case. Vomiting is also prominent and is characterized by the presence of fecal material in the vomitus together with fecal odor of the breath. There is extreme loss of weight with marked emaciation and signs of nutritional deficiency. Pain may be of varying intensity. The incidence of complaints in this series as as follows:

	Per cent
Diarrhea	100
Weight loss	84
Pain	49
Vomiting	42
Fetor oris	37
Bleeding	32

Barium enema examination offers the most accurate means of establishing the presence of a suspected fistula. In this series the enema succeeded in demonstrating the lesion in all cases. Gastrointestinal series is valuable but rates second to the enema in efficiency as a diagnostic measure. In contrast to the barium enema, by which fistulas were demonstrated in 100 per cent of the cases, the gastrointestinal series showed the fistulas in only 8 cases and was questionable in 1 case (representing accuracy in 45 per cent of the studies). The reason for this discrepancy has not been determined but the possibility of a valve-like mechanism at the stoma has been suggested.

Once the diagnosis has been made, treatment of this condition is entirely surgical.



a b

Fig. 3. H. Z., 59 year old male, upon whom an undetermined type of gastroenterostomy had been performed in 1922, developed symptoms of a marginal ulcer 21 years later. Treatment at this time was conservative, with good relief. Four years later (1947) he experienced abdominal pain, vomiting, malaise, nausea, and weight loss associated with a marked diarrhea. a, A gastrojejunocolic fistula was demonstrated by barium enema and gastrointestinal series done 4 weeks after the onset of the above symptoms and signs. The esophagus (*E*), stomach (*S*), and proximal jejunum (*J*) filled rapidly during barium enema. b, Twenty-four hours following ingestion of barium there is contrast medium in the large bowel, some of which has re-entered the stomach through the fistula. This barium re-opacifies segments of the small bowel. No follow-up was obtained after the patient's discharge from the hospital.

Prompt removal of the abnormal shunt must be performed. Because of the debilitated condition of the majority of these patients a carefully planned regimen must be followed consisting of transfusions, amino acid and vitamin supplements, and correction of nutritional deficiencies. Correction of the debilitated condition and reinstitution of proper protein balance results in a lower operative mortality and speeds immediate postoperative convalescence. Often the correction of these deficiencies is most difficult and, despite intensive therapy, no improvement occurs making operative intervention mandatory in order to prevent a further downhill course.

At The New York Hospital, the earliest cases were treated by simple removal of the fistulous tract. This procedure proved to be totally inadequate and was followed by the return of symptoms and a recurrence of the fistula. Later, in addition to resection of the fistula, a dismantling of the gastroenterostomy was done with resection of the involved segment of the jejunum followed by end-to-end anastomosis of the transected bowel. The gastric stoma was closed; the normal pathway of the gastrointestinal tract was re-established. This method of treatment also resulted in exacerbations of ulcer symptoms; very often the old duodenal ulcers became reactivated and serious hemorrhages occurred. Two of our patients having this type of treatment died of hemorrhage from the original reactivated duodenal ulcers.

At the present time, the procedure of choice is an extensive one. The fistulous tract is

Fig. 4. J. M., 45 year old male, had his first operation 18 years previously; this consisted of plication of a ruptured duodenal ulcer. Eight years later a posterior gastroenterostomy was necessary because of severe ulcer symptoms. He then remained symptom-free until 7 weeks before admission to The New York Hospital; at this time he presented symptoms of severe diarrhea, fecal vomiting, and had passed undigested food in his stools. Clinically the patient was thought to have a carcinoma of the colon. The barium enema demonstrated the gastrojejunocolic fistula. The stomach (*S*), jejunum (*J*), and colon (*C*) were outlined by this means. After a dismantling operation with subtotal gastrectomy, the patient was discharged and lost to follow-up.

resected with the involved segment of jejunum. The continuity of the jejunum is re-established by end-to-end anastomosis. The defect in the colon resulting from resection of the fistula is closed transversely. It was at this stage that previous surgical repair was considered adequate. It is realized now that a subtotal gastrectomy with gastrojejunostomy must be undertaken before the disease is considered fully corrected. This formidable operation may be undertaken more safely after proper attention has been directed to the preoperative preparation of the patient. The advantage of this method is apparent. No cases of gastrojejunocolic fistulas have been reported subsequent to subtotal gastrectomy. In addition, all patients having had this type of repair have been comparatively free of symptoms related to the gastrointestinal tract in follow-up examinations after 2½ to 8 years.

CASE REPORTS

CASE 1. M. R., Hospital No. 374–386, fourteen year old male. This case represents the second youngest patient mentioned in the literature. The patient, at the age of 12, was admitted to another hospital because of complaints of "gas on the stomach," anorexia, and midepigastric pain. During hospitalization he had 2 massive intestinal hemorrhages. Treatment was conservative, following which he was much improved. He was discharged from the hospital and remained asymptomatic for 2 months. Due to dietary indiscretion all symptoms recurred together with vomiting and weight loss. He was readmitted to the same institution for dietary regulation following which improvement resulted. After an interval of 1 year, the patient was admitted to The New York Hospital where a diagnosis of duodenal ulcer with obstruction and chronic appendicitis was made. Posterior gastroenterostomy and appendectomy were performed following which the patient was discharged improved. He was relatively free from symptoms for about 1 year. He then developed pain in the left chest and right upper quadrant. Vomiting without evidence of blood occurred on 1 occasion. There was some diarrhea. He was readmitted to this hospital where physical examination showed a thin, undernourished, pale boy with some tenderness in the right upper quadrant. Significant abnormal laboratory findings were a hemoglobin of 34 per cent, 3.1 million red blood cells, and a prothrombin of 47 per cent. A barium enema revealed a defect in the colon with a fistulous tract to the stomach. The stomach and proximal loops of jejunum, under fluoroscopic observation, filled rapidly with barium. There was a strong suggestion of a marginal ulcer near the stoma of the gastroenterostomy. The diagnosis of gastrojejunocolic fistula was made. A gastrointestinal series performed 3 days later showed the presence of a posterior gastroenterostomy but completely failed to demonstrate the fistulous tract. At operation, the fistulous tract was found, and this, together with the involved jejunum, was resected; end-to-end anastomosis of the jejunum, closure of the colon, and gastric resection were done. A postoperative gastrointestinal series 1 month later showed excellent function of the stoma. At this time an ulcer of the lesser curvature of the remaining stomach was found. This was followed by the onset of abdominal pain and gastric hemorrhage. The bleeding became more severe and the patient died of exsanguination.

CASE 2. G. I., Hospital No. 61–847, fifty year old male. This patient's ulcer symptoms occurred prior

to 1927, at which time a posterior gastroenterostomy was done to relieve pyloric obstruction secondary to stenosing duodenal ulcer. He remained well for over 6 years, but then developed loose watery stools (6 to 8 daily) containing blood, pitting edema of the lower extremities, and a weight loss of 14 pounds. Fecal belching was noted. The clinical diagnosis was "amebic dysentery." Barium enema revealed a gastrojejunocolic fistula. At operation, the fistulous tract was removed and the defects in the jejunum and colon were repaired. The gastroenterostomy was not disturbed. The patient was symptom-free for over 2 years. At this time, there was onset of diarrhea, occasionally blood-tinged, associated with moderate weight loss. A barium enema again demonstrated the presence of a gastrojejunocolic fistula. The gastrointestinal series was of special interest; the immediate films did not demonstrate the presence of the fistula. The stomach emptied completely, but the 24 hour film revealed the presence of the fistula by regurgitation of barium from the colon into the stomach. The patient was subjected to a third operation much more extensive than the preceding one. The gastroenterostomy was dismantled; it was then discovered that there were 2 separate fistulous tracts from the large bowel into the gastroenterostomy. This case demonstrates the extremely rare occurrence of double fistulas and is probably the first case reported since that of Haufmann and Gorsset in 1925. The involved jejunum was resected; the defects in the stomach and colon were closed. It should be noted that the operative procedures upon this patient were performed before gastric resection was popularized. Death from bronchopneumonia resulted on the fourth postoperative day.

CASE 3. J. W., Hospital No. 128–250, twenty-nine year old male. This patient was first seen in 1936 at which time he gave a 7 year history of gnawing epigastric pain. One year before he was examined at our hospital he had had a posterior gastroenterostomy because of bleeding duodenal ulcer. Following this surgery he remained symptom-free for almost a year. He then noted onset of epigastric pain, tarry stools, and weakness. Roentgenograms made at this time revealed only a normally functioning gastroenterostomy. The surgeons deemed it advisable to dismantle the gastroenterostomy and part of the jejunum was removed at this operation. The patient remained asymptomatic following this procedure for another year, but in 1937 he began to experience epigastric distress, nausea, vomiting, and pain. The vomitus was occasionally coffee-ground. There was considerable weakness, but no diarrhea was present. Treatment at this time was conservative with resulting improvement. He was readmitted after an interval of 10 months because of severe epigastric pain, nausea, vomiting, and tarry stools. A gastrointestinal series demonstrated a pyloric canal ulcer with gastric retention. The patient was operated upon with the intention of performing a gastric resection but because of dense adhesions only a posterior gastroenterostomy could be done. After an interval of 2 years, periumbilical pain occurred associated with weight loss, severe diarrhea (7 to 8 times daily, immediately following meals), foul belching, and vomiting. A barium enema and a gastrointestinal series demonstrated the fistulous tract. The patient was brought to surgery where the fistulous tract was resected, the gastroenterostomy dismantled, a subtotal gastric resection with gastrojejunostomy performed, and the jejunum and colon repaired. It is of interest to note that the fistulous tract involved the proximal (afferent) loop of jejunum; this is a rare occurrence. The patient has been asymptomatic for the past 7 years.

SUMMARY AND CONCLUSIONS

Gastrojejunocolic fistula is an abnormal communication between the stomach, jejunum, and colon. It occurs predominantly in males.

In each of the 19 reported cases, the development of the fistulous tract was preceded by operative procedures performed for relief of duodenal ulcer; the operative method used most frequently was the posterior gastroenterostomy. In 5 of our cases, the type of gastroenterostomy was not specified but we believe that the kind performed was most likely the posterior anastomosis. The previous surgical creation of an abnormal shunt is, therefore, necessary for development of a gastrojejunocolic fistula. This sequence is applicable to those cases in which the operation has been performed for the treatment of a duodenal ulcer; in our series, the fistulous tracts developed in periods varying from 1½ to 21 years after the primary surgery. A fistula developing as the result of carcinoma need not be preceded by surgical intervention.

The fistulous tract generally involves the site of gastrojejunal anastomosis and occasionally may be located in the efferent loop of jejunum. The symptoms of the fistula in the order of frequency are: diarrhea, weight loss, pain, vomiting, fetor oris, and hemorrhage.

Barium enema offers the most accurate means of diagnosis. The treatment of choice at this time is entirely surgical and consists of dismantling of the gastroenterostomy, resection of the fistulous tract and involved jejunum, end-to-end anastomosis of the jejunum, closure of the defect in the colon, and subtotal gastrectomy with gastrojejunostomy. Three case histories are reported in greater

detail because of their special interest; one is that of a child of 14 years; the second is that of a patient who developed a total of 3 fistulous tracts, 2 of these occurring simultaneously; the third is that of a patient with a fistulous tract involving the proximal or afferent loop of jejunum.

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EXPERIMENTAL ANASTOMOSES OF THE COMMON DUCT

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RECONSTRUCTIVE surgery of the biliary tract in cases of stricture or of neoplasm necessitating interruption of the ducts has been a difficult problem. Many techniques have been devised to avoid the two chief complications, viz., stricture at the anastomosis site and ascending cholangitis resulting from regurgitation of gastrointestinal contents into the biliary system. It is with the former that the present report is concerned.

Usually an anastomosis between the gall bladder and the gastrointestinal tract provides an adequate stoma. Many surgeons, however, prefer to use the common duct itself in performing the anastomosis. Furthermore, in many cases the gall bladder is absent or is diseased to an extent that choledochoenterostomy is a necessity.

Blocker, Hendrix, Herrmann, and Hall (1949) suggested the transposing of a triangular flap of skin or mucous membrane into a V-shaped opening in the margin of the hollow tube when the tube is to be anastomosed to a surface, as in performing a permanent tracheotomy or in implanting a stump of parotid duct into the mouth. They have shown that there is less tendency for stricture formation at the site if this method is used. A circular scar as it contracts tends to narrow the orifice while a scar with a V-limb included in it merely tends to straighten out the V instead of narrowing the opening. Moreover the stoma is made larger by this method (Fig. 1). Blocker has also demonstrated experimentally a method using a modified Z-plastic by which hollow tubes may be joined together with less tendency to stricture formation at the suture line (Fig. 2).

We have attempted to apply these methods in anastomosis of the common bile duct in dogs. In the average dog the duct is found to be so small and its wall so fragile that preliminary distal ligation is necessary to render the duct sufficiently dilated and strong for plastic surgery to be practicable. In a series of dogs 2 or 3 weeks after such preliminary ligation the duct was cut across just proximal to the site of ligation. A vertical slit was made in the anterior wall of the proximal duct extending from the end about 0.5 centimeter proximally. An inverted V-incision was then made in the antimesenteric border of the duodenum and a choledochoduodenostomy performed using interrupted No. 00000 arterial silk sutures passing through all layers, the tongue-like portion of the duodenal incision fitting into the slit in the wall of the common duct (Fig. 3). In 10 animals in which this procedure was performed there was no stenosis when the animals were sacrificed, 3 animals at 3 weeks, 2 at 3 months, 2 at 4 months, 1 at 5 months and 2 at 6 months after implantation. An 11th animal was sacrificed 1 day after operation, at which time the anastomosis was found to be patent with no sign of leakage. There was no postoperative death in the entire series.

Binkley, Palmer, and McCorkle (1947) have recommended a "pull-through" type of choledochoduodenostomy which they perform in dogs with excellent results. They pulled the proximal end of the severed common duct through one small opening in the duodenum, working through another duodenal opening which was closed at the completion of the

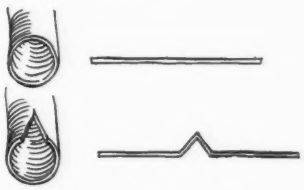

Fig. 1. Diagram showing increase in circumference of stoma made by splitting end of duct.

From the Department of Surgery, Medical Branch, University of Texas.

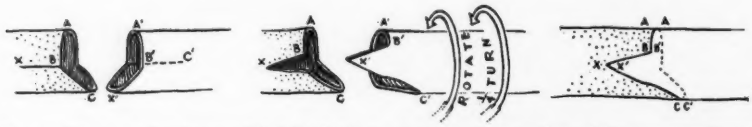

Fig. 2. Diagram showing modified Z-plastic in anastomosing portions of the common duct.

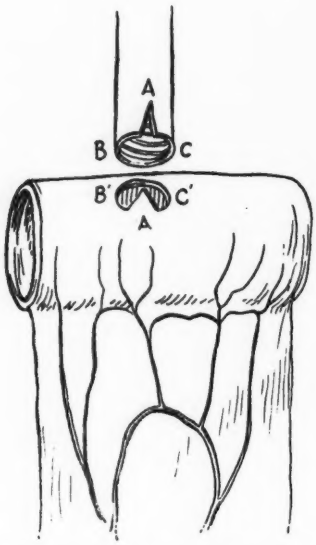

Fig. 3. Diagram showing anastomosing of common duct to duodenum with triangular flap of bowel wall inserted into slit in duct.

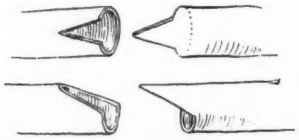

Fig. 4. Diagram showing modified V-plastic in anastomosing portions of common duct.

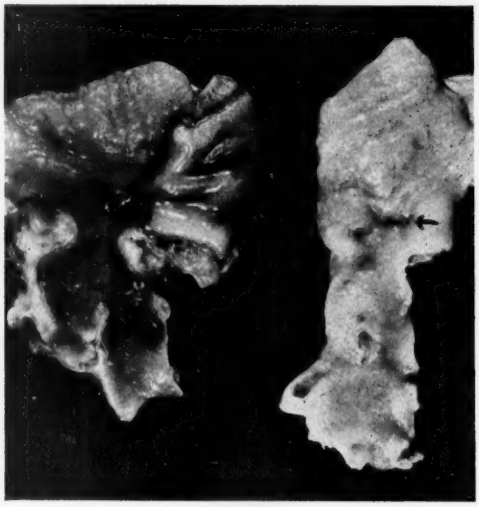

Fig. 5. Photograph of V-plastic anastomoses in dogs 6 months after operation. Arrows indicate site of suture line; common duct above, duodenum below. Broadening of common duct by juncture with right hepatic duct just above suture line suggests narrowing at the stoma, but lumen actually has same diameter as common duct.

procedure. The duct was sutured so that its end protruded into the intestinal lumen. We have tried this procedure in 8 dogs. Four died in the early postoperative period. The anastomosis was patent and showed no sign of leakage so that it appeared that death had resulted from some other cause. The other 4 animals survived 2 to 7 months. One of these had a satisfactory anastomosis without narrowing when sacrificed at 4 months, but each of the 3 others showed some stenosis of the orifice when sacrificed at 2, 4½, and 7 months, respectively.

Side-to-side choledochoduodenostomy was not successful in our hands. With this method, length must be sacrificed in a duct which already is short.

End-to-end anastomosis is difficult in the dog because of the small size of the bile duct. While the Z-plastic technique described by Blocker for intestinal anastomosis (Fig. 2) was used successfully in the end-to-end anastomosis of larger ducts, the smaller the duct the more difficulty was encountered in forming and suturing the flaps. However, it is in the case with the small duct that some nonstenosing method is most needed. In this situation a modification of the V-limb prin-

ciple can be used, making a vertical slit in one duct end and cutting the other duct end obliquely or on the bias (Fig. 4). In 4 such cases in which it was believed that the anastomosis had been constructed satisfactorily there was no stenosis after 6 months. However, in other cases in which the anastomosis had seemed unsatisfactory because of the smallness of the duct, constriction did occur.

McWhorter in 1929 reported good results in common duct anastomoses in animals, using a "riband" oblique type of suture line which is similar to the methods that we have used.

It is concluded that V-flap methods and other modified Z-plastic procedures can be used to advantage in choledochoduodenostomy and in end-to-end anastomosis of the common bile duct.

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THE USE OF RADIOACTIVE IODINATED PLASMA PROTEIN IN THE STUDY OF BLOOD VOLUME

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IN recent years the importance of the circulating blood volume and its relationship to disease has become more evident. The direct method for determining blood volume, which is of importance clinically, depends upon the dilution of a test substance injected into the blood stream. The requirements of an ideal test substance are that: (1) it remains in the vascular system for a relatively long period; (2) it mixes readily with the normal constituents of blood; (3) it is easily identified and measured; and (4) it is nontoxic.

The azo dyes have been the chief source of these test substances. The extensive investigations of one of these dyes, T-1824, by Gibson, Gregerson, and others (3, 4, 1) have led to its widespread clinical and experimental use for the determination of blood volumes. These investigators have shown that, under the proper conditions, relatively accurate results can be obtained by this method.

More recently, with the availability of radioactive isotopes, easier and more accurate means of estimating blood volumes have evolved. Hevesy first utilized radioactive phosphorus for labeling erythrocytes to study total circulating erythrocyte mass. Hahn, by feeding radioactive iron to donors, devised an excellent alternative method for determining red cell volume. Although these methods have given satisfactory results, both present practical disadvantages. The latter method requires a donor with the appropriate blood type. With the radioactive phosphorus method, there is an undesirable delay required in the preparation of the labeled red cells before the determination can be performed.

Fine and Seligman devised a method by which they could label plasma protein with radioactive iodine, and with this material study plasma volumes in experimental animals. This method was selected by us and its efficacy in the study of blood volumes in humans was investigated. Iodinated protein appears to satisfy the requirements listed and has the significant feature of being derived from a normal constituent of plasma.

Blood volume studies on 76 human subjects will be reported here. The subjects were ambulatory hospital patients in normal fluid and protein balance. In 30 of the individuals, the disappearance of the iodinated protein from the vascular system was studied over an 8 hour period. In 31 patients, plasma volume studies were determined under basal conditions. In 15 patients, a comparison of plasma volumes determined with both T-1824 and iodinated protein was made.

Since the iodinated albumin disappears from the blood stream, as will be shown subsequently, experimental procedures were undertaken, in animals and humans, to determine the fate of the injected material.

FATE OF THE IODINATED PROTEIN IN VIVO

The distribution of iodinated rat plasma protein after intravenous injection was obtained in a group of 16 albino rats for various intervals up to and including 24 hours. Various organs and tissues were assayed and their radioactivity was compared to that of the plasma. The thyroid gland was the only organ showing significant amounts of radioactivity. During the 24 hour period of this experiment, the radioactivity in this organ increased with time so that approximately 5 per cent of the total activity was found in the thyroid gland at the end of 24 hours. The radioactivity of the other tissues and organs was negligible and appeared to depend upon the vascularity of the tissue. Figure 1 shows the gross distribution of iodinated protein by means of radio-

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autographs, made from transections of rats. There appears to be little difference in the distribution of the injected material at 6 and 24 hours. The vascular channels are well outlined in each radioautograph.

The urine and body tissues of 2 dogs were assayed for activity 12 and 24 hours after the intravenous injection of iodinated protein. Urine was collected continuously throughout the periods of observation. The tissues examined for radioactivity consisted of thyroid, spleen, liver, kidney, muscle, fat, and intestine. The radioactivity measured in these tissues, when compared to that of blood, was found to be negligible and for practical purposes could be accounted for by the presence of the blood in the vascular channels contained within the examined tissues. At the end of 12 and 24 hours, the urine contained respectively 3.2 and 7.6 per cent of the injected radioactive iodine.

Experimental studies have been conducted and reported elsewhere (8) on the rate of appearance of radioactive protein in thoracic duct lymph after an intravenous injection. The details of these experiments will not be presented here except to state that 10 minutes following the injection of the radioactive protein a negligible amount (under 2 per cent) was found in the lymph. This was sufficiently small to be disregarded in the determination of the plasma volume. As time progressed, however, the radioactivity of the plasma and lymph approached equilibrium. It was also determined by dialysis that the radioiodine remained bound to protein.

Twelve patients who were to receive spinal anesthesia were given radioactive iodinated protein at various intervals preceding the administration of the anesthesia. In no instance could any radioactivity be detected in the spinal fluid. In 6 of these patients, biopsies of muscle and fat obtained during the course of the operation showed very little radioactivity. In 1 patient, bile was obtained 45 minutes after intravenous injection of iodinated protein and no significant activity was found. Studies on patients confined to bed have shown that an average of 8 to 12 per cent of the injected radioactive iodine is found in the urine in 24 hours.

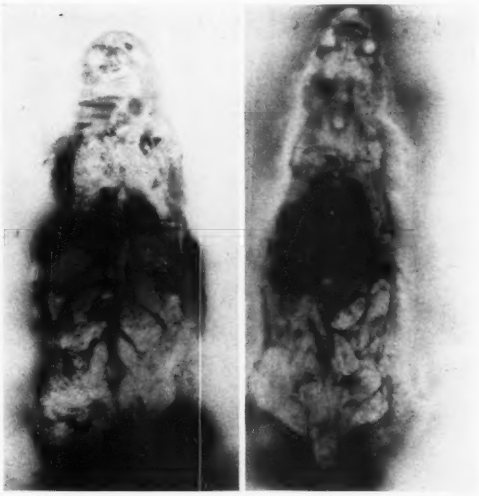

Fig. 1. Radioautographs of rats made at 6 and 24 hour intervals. The dark shadows represent the distribution of iodinated protein. The vascular channels are well outlined.

From these studies it was observed that the disappearance of iodinated protein from the vascular system probably occurs in two ways.

The first is due to the liberation of radioactive iodine from the protein. This is manifested by the excretion of iodine in the urine as well as by the increased radioactivity over the thyroid gland. The second is due to the diffusion of iodinated protein from the vascular bed to the extravascular spaces, as demonstrated in the studies of thoracic lymph.

METHOD

The studies on human subjects were performed while they were in a fasting state. The subjects were confined to bed until the experiment was completed, with the exceptions to be noted. During the earlier part of this work, careful records of the blood pressure, pulse, respiratory rate, urinary output, and emotional state of the patients were made. When no perceptible change was observed, these measurements were discontinued. In studies designed to determine the disappearance rate of iodinated protein from the plasma, fasting conditions and confinement to bed were maintained for 6 hours. (The effect on the contour

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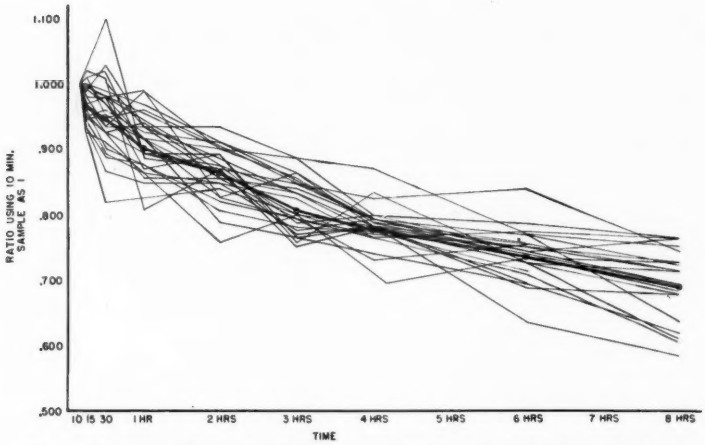

Fig. 2. This graph shows the disappearance of iodinated protein from the blood in 30 patients. The 10 minute sample was used as a reference point. The "heavy line" is the composite curve of the group.

of the disappearance curve when these restrictions were eliminated will be discussed.) The height and weight of each patient were recorded.

The radioactive iodine used in this work was a fission product obtained from the Isotope Division of the Atomic Energy Commission at Oak Ridge, Tennessee. The isotope was radioactive iodine with a half life of 8 days. Radioactive iodine decays by emitting both beta particles and gamma rays. Measurements of the radioactivity were made by utilizing the beta particles of radioactive iodine. Gamma counting of samples of plasma was not attempted because of the low efficiency with the conventional methods. Gamma counting was employed only when the patients were surveyed with a portable Geiger-Mueller counter. (In these circumstances, only the gamma rays will be detected by the counter since the beta particles are readily absorbed in a few millimeters of tissue.)

As noted previously, the iodinated protein was prepared according to the method originally described by Fine and Seligman. In this method of fixing the radioactive iodine to the protein, about 15 to 30 per cent of the iodine is bound to the albumin fraction[1]. The iodinated protein solution is then diluted with a sufficient quantity of 0.9 per cent saline solution so that there are approximately 2 to 3 microcuries of radioactive iodine per cubic centimeter of solution to be injected. There is less than 1 gram of protein in the quantity of solution to be injected for each determination. During the initial part of this work, human plasma was used as a source of protein, but for the past year human serum albumin has been used.

For each determination exactly 20 cubic centimeters of the iodinated protein solution were injected intravenously. This was used to minimize the error of injection[2]. At the desired time intervals after injection, 6 to 8 cubic centimeters of whole blood were withdrawn without stasis from a vein and placed in a calibrated test tube containing a few particles of crystalline heparin. The blood was centrifuged at 3,500 revolutions per minute for 20 minutes and exactly 1 cubic centimeter of the supernatant plasma was pipetted into a porcelain crucible and allowed to dry in air. The radioactivity was measured with a Geiger-Mueller counter. The conventional bell-shaped end window Geiger tube, placed at a fixed distance, was used. Exactly 1 cubic

[1]At the present time, iodinated human serum albumin is being prepared in which yields have been obtained with 70 to 80 per cent of radioactive iodine bound to the albumin.

[2]Smaller volumes can be used. We find, however, that larger volumes are easier to handle. With 20 cubic centimeters volumes, the error of injection could be kept within ± 1 per cent.

TABLE I.—THE AVERAGE RATIO OF DISAPPEARANCE RATES OF IODINATED PROTEIN FROM BLOOD IN 30 PATIENTS FOR VARIOUS INTERVALS UP TO 8 HOURS

Time	Average ratio*	Standard deviation	Coefficient of variation
5 min.	1.055	±.036	±3.4
10 min.	1.000		
15 min.	.963	±.027	±2.8
30 min.	.947	±.047	±5.0
60 min.	.900	±.041	±4.5
2 hr.	.862	±.041	±4.7
3 hr.	.808	±.040	±4.9
4 hr.	.778	±.030	±3.8
6 hr.	.737	±.035	±4.7
8 hr.	.689	±.059	±8.5

*The average ratio is the value of each point on the heavy line (composite curve) in Figure 2.

centimeter of the original iodinated protein solution, diluted 1 to 100 with plasma, was used as a standard. Use of the latter rendered calculation of the plasma volume simple, by obviating the necessity of considering decay and the geometry of the counting system. The porcelain crucibles were constructed so that 1 cubic centimeter of solution just covered the bottom. The plasma samples and the standard preparations were dried in air for 24 hours before the counting was performed. This was necessary because many samples were being counted simultaneously. (The plasma volume, however, can be determined by counting the wet plasma specimen without loss of accuracy.) Each sample was counted for a long enough period of time to reduce the counting error to less than 2 per cent. Total counts per sample were usually around 5,000. Hematocrits and plasma protein concentrations were obtained from specific gravities measured by the copper sulfate method. Reference was made to the charts provided by Phillips and co-workers. At the present time, protein determinations are being performed by the use of a photoelectric colorimeter (7). The plasma volume was calculated from the following formula:

$$\frac{\text{Counts in standard per c.c.} \times \text{volume injected} \times \text{dilution of standard}}{\text{Counts in sample per c.c.}} = \text{Plasma volume}$$

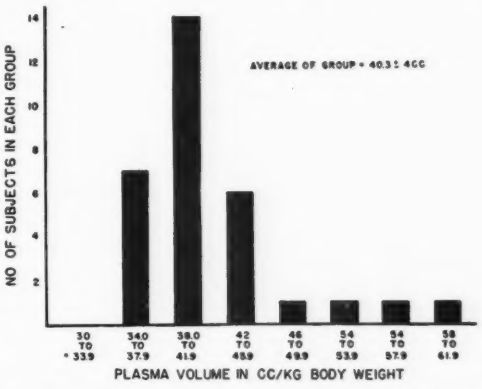

Fig. 3. This graph shows the distribution of plasma volumes, determined with iodinated protein, in cubic centimeters per kilogram body weight in 31 normal subjects.

The total blood volume was calculated as follows:

$$\frac{\text{Plasma volume}}{100 - \text{hematocrit}} = \text{Blood volume}$$

RESULTS AND DISCUSSION

To determine the rate at which the iodinated protein disappeared from the blood stream, 30 patients were studied. These patients were healthy individuals who had been admitted to the hospital for hernioplasties or plastic repairs. In order to measure the disappearance rate, the plasma specimen obtained 10 minutes after injection was used as a reference point and designated as unity. We assumed this to be the time of maximum mixing and minimum loss from the blood stream. The 10 minute interval may not represent the optimum time. Other time intervals following injection may be desirable, when cardiovascular dynamics and capillary permeability in localized areas of the body are altered. Experiments are being performed at the present time in an attempt to arrive at a more satisfactory solution of this problem.

By dividing the counts of successive samples of plasma over a 24 hour period by the count of the 10 minute sample, ratios were obtained which indicated the rate of disappearance of the radioactive protein. The ratios obtained at various intervals were plotted as noted in Figure 2. The composite curve (heavy line) was obtained by plotting the

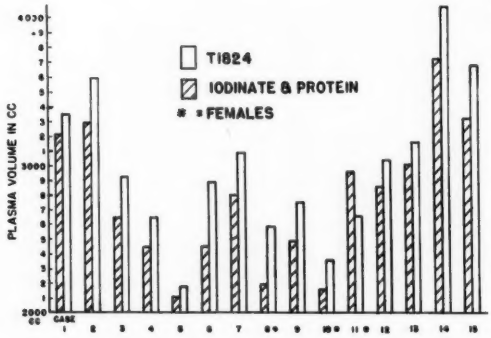

Fig. 4. This graph compares plasma volume determinations performed simultaneously using T-1824 and iodinated protein. In only 1 instance (Case 11) was the volume obtained by T-1824 less than that by the iodinated protein.

averages of the ratios at each interval for all the patients. Table I demonstrates the average disappearance ratio at each time interval with standard deviations and coefficient of variation.

It may be seen that the iodinated protein leaves the blood stream at a slow rate. At the end of 1 hour, 90 per cent of the injected protein is still present in the blood; at the end of 4 hours, 78 per cent remains; and 24 hours following the injection, 55 per cent remains although this is not shown in Figure 2 or Table I.

The narrow percentage of deviation or coefficient of variation for each curve gives considerable significance to the composite disappearance curve. Up to and including the 6 hour specimens, the percentage of deviation was under ± 5 (Table I). This is well within the range of error suitable for biological measurement. At the end of 8 hours, the percentage of deviation attains ± 8.5 and at 24 hours it is greater. This increase in the coefficient of variation after 6 hours may, in part, be explained by the abolition of controlled conditions. After 6 hours the patients were allowed out of bed and fluid intake was unrestricted.

Since the iodinated protein disappears from the blood stream at a reasonably fixed slow rate, it should be possible to calculate the plasma volume by determining any point on the disappearance curve from 10 minutes to 6 hours after the injection of the radioactive iodinated protein. Large deviations from the normal disappearance curve should be easily detectable if there is no significant loss of protein from the blood stream as a result of blood loss or localized change in capillary permeability during the course of the study.

TABLE II.—NORMAL BLOOD VOLUME STUDIES IN HEALTHY MALES

Name	Age years	Weight in kgm.	Plasma volume c.c.	Plasma volume c.c./ kgm.	Hematocrit	Total blood volume	Total blood volume c.c./ kgm.
1. R.W.	20	68	3865	56.8*	34.9	5946	87.4
2. J.M.	26	77	3162	41.1	45.3	5749	74.6
3. W.F.	25	82	2972	36.2	48.2	5715	70 5
4. W.W.†	28	80	3422	42.7	41.9	5900	73.7
5. A.A.	54	76	3417	44.9	43.8	6101	80.2
6. I.A.	38	73	2921	40.0	48.7	5727	78.4
7. W.R.	27	64	2564	40.0	40 3	4240	66.3
8. A.M.	40	58	2251	38.8	48 0	4328	74.6
9. H.C.	24	73	2451	33.6	46.2	4724	64.7
10. H.M.	37	75	2856	38.0	45.0	5129	68.4
11. J.B.	31	73	2695	37.0	39.3	4418	60.5
12. S.C.	29	66	2773	42.0	45.0	5041	76.3
13. D.M.	38	74	2903	39.2	46.0	5375	72.6
14. G.K.	25	65	2378	36.6	39.0	3898	60.0
15. P.N.	30	68	2738	40.3	48.0	5265	77.4
16. J.W.	34	74	2521	34.0	42.4	4518	61.0
17. W.W.†	28	88	3305	37.5	37 8	5331	61.0
18. R.R.	38	88	3720	42.3	48.7	6888	78.3
19. J.G.	27	88	3110	35.3	45 9	6100	69.3
20. R.M.	26	74	2884	39.0	47.7	5546	75.0
21. G.P.	29	63	3894	61.8*	36.3	6048	96.0
22. F.N.	28	82	4010	48.9	42.1	6913	84.3
23. H.B.	30	59	3125	52.9	38.1	5040	85.4
24. W.H.	29	60	2530	42.2	40.5	4300	71.6
25. R.N.	24	100	3420	34.2	46.3	6340	63.4
26. T.T.	18	58	2580	44.5	43.1	4550	78.5
27. J.K.	40	90	3380	37.5	46.0	6450	71.6
28. P.W.	21	56 5	2260	40.0	47.0	4280	75.7
29. F.S.	30	66	2710	41.0	49.0	5350	81.0
30. N.P.	29	77	3500	45.0	47.0	6650	86.5
31. A.G.	35	67.5	2740	40.6	48.0	5270	78.5

Average plasma volume in c.c./kgm. 40.3 ± 4.2.
*Patients excluded from calculation of average value since their plasma volumes in c.c./kgm. were greater than 3 standard deviations from the mean.
†Patients No. 4 and 17 are the same patient. Plasma volumes were done 1 month apart.

Plasma and blood volumes were determined on 31 male patients (Table II). Their ages ranged from 18 to 54 years, although the majority of them were between 25 and 35 years of age. Their weights ranged from 56.5 to 100 kilograms. Plasma volumes ranged from 34.0 to 61.8 cubic centimeters per kilogram.

Correlation of plasma or blood volume with any readily determined biologic measurement such as height, weight, or surface area, is not entirely satisfactory. Figure 3 demonstrates the distribution of patients according to cubic centimeters of plasma volume per kilogram of body weight. Fourteen of the 31 patients fall between 38 and 42 cubic centimeters per kilogram, whereas 27 of the 31 patients fall between 34 and 46 cubic centimeters per kilogram. The mean plasma volume per kilogram of body weight is 40.3 ± 4.2 cubic centimeters. The correlation coefficient of plasma volume with weight was found to be .47 in our series of 31 patients. Since weight is obviously an unsatisfactory biologic measurement for predicting plasma volumes, it is essential that predetermined normal plasma volume measurements be obtained in each individual to be studied. This will permit estimation of subsequent deviations from the normal when physiological alterations occur.

An important biological measurement which may be used as a basis for estimating plasma volume is the specific gravity of the whole body. Such a measurement involves the total weight and volume of the individual. The latter can be done only by water displacement. This procedure is not one to which a sick patient could be subjected. Furthermore, it would be of little value in physical conditions associated with marked water deficit or excess. Studies are in progress to determine if the relationship between body specific gravity and plasma volume is of practical value.

Figure 4 demonstrates a comparison of plasma volumes determined simultaneously with radioactive iodinated protein and T-1824 in 15 individuals. Blood specimens were drawn 10 minutes after the injection of both the dye and iodinated protein. The most significant feature of this study is that the plasma volumes determined with the use of the radioactive protein were, with 1 exception, smaller than those obtained with the dye T-1824. This was found to be true also in the case of work in dogs in which we compared the volume by using T-1824, iodinated protein, and red cells labeled with radioactive phosphorus (9). Figure 5 gives the results of this study. These results show that at the 10 minute interval there is a greater dilution of T-1824 than of iodinated protein. Since the determinations were done simultaneously, the greater dilution of the dye must present a greater loss of the dye from the vascular spaces. The minimum time required for complete mixing of an intravenously injected material within the blood stream is not known accurately. There is, indeed, some reason to believe that it varies in different physiological and pathological states. It may be that, as more information is obtained concerning the mixing time, the 10 minute interval between the injection and the withdrawal of blood will have to be revised.

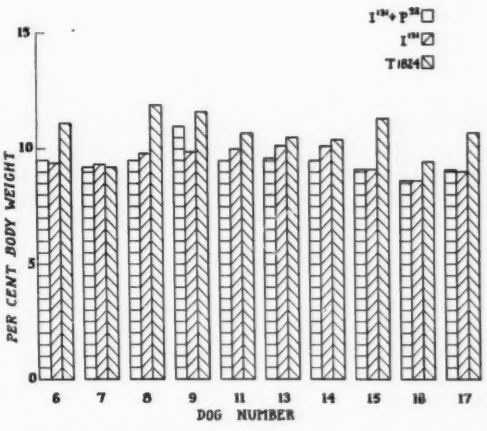

Fig. 5. This graph gives a comparison of total blood volumes (expressed as per cent body weight) in dogs using iodinated protein and radioactive phosphorus labeled red cells, iodinated protein and hematocrit, and T-1824 and hematocrit. In only 1 instance (dog 7) was the blood volume determined with T-1824 less than by the other two methods. Published with permission of *Proceedings of the Society for Experimental Biology and Medicine.*

Rawson has proved that the successful use of T-1824 depends upon its rapid and complete binding to the albumin fraction of plasma. However, during the first few minutes following the injection of T-1824, a cer-

tain amount of the dye escapes from the vascular system. This will vary from one individual to another and will also depend upon the protein status of the patient.

A far greater advantage of the use of iodinated protein in determination of blood volume is the fact that repeated blood volume determinations after short intervals of time can be carried out on the same individual. This is not true of T-1824. Rawson has found by electrophoresis that the dye is completely bound to albumin when the concentration is .004 per cent or less. Any further injection of T-1824 into the blood stream will be rapidly and effectively taken out by the reticuloendothelial system.

SUMMARY

A method of determining the plasma volume of patients has been presented. It involves the measurement of the dilution of protein tagged with radioactive iodine after intravenous injection. Dilution is determined by measuring iodinated protein labeled with radioactive iodine before the injection and plasma periodically after the injection.

The technique of the procedure is simple and subject to small error. Repeated determinations can be performed within a short time.

The stability of the iodinated protein and its relatively secure retention within the vascular system permit a more accurate estimate of the plasma volume than has hitherto been possible. This method is probably of no more value than others when there is marked disturbance of normal physiology, as in profound shock, or other conditions effecting capillary permeability.

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MALIGNANT BLOOD VESSEL TUMORS

A Report of 56 Cases of Angiosarcoma and Kaposi's Sarcoma

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A REVIEW of medical literature reveals the need of a more comprehensive pathological and clinical study in the confused field of malignant tumors of blood vessel origin. The present confusion in the classification and treatment of such neoplasms results mainly because the literature is fragmentary and rests upon isolated case reports with little correlation of all angiosarcomas. In an effort to open a new avenue of study on the problem, the authors have collected a group of 56 cases of all types of angiosarcoma from the files of Memorial Hospital over a 10 year period. Included in the total of 56 cases are 36 patients with tumors diagnosed as Kaposi's sarcoma, which is now considered a true sarcoma of blood vessel origin. The presentation is on a comparative basis and the whole aggregate of cases is utilized as a nucleus for discussion of recent developments in the etiology, pathology, experimental tumor production, diagnosis and therapy of such neoplasms. In addition, supplementary information has been drawn from a previous review of 1,056 benign blood vessel tumors from Memorial Hospital case reports (30).

KAPOSI'S SARCOMA

Kaposi's sarcoma, or "idiopathic multiple hemorrhagic sarcoma," was first described by Kaposi in 1872 as a clinical entity and is more common than the literature would indicate. Undoubtedly many cases throughout the world are unreported or unrecognized. Nevertheless, over 600 case histories have been published to date, but inasmuch as the majority are isolated case reports, a concise correlation of data has been difficult. It now appears that the disease moves through a wide range of histological and clinical variations, largely influenced by racial and hormonal factors, in the authors' opinion, all of which further complicate simple classification.

From the Memorial Cancer Center, New York, New York.

Definition. Kaposi's sarcoma is a true but atypical sarcoma which generally has its onset as a single bluish-red macule on the extremities of individuals over 40. The microscopic picture of the early macule is deceptive in that it is essentially inflammatory in appearance with little to suggest its invariable progression into ultimate sarcoma. As the macules slowly multiply and coalesce into indurated plaques, the disease gradually involves both lower extremities symmetrically in a "stocking" distribution, spreading to the trunk and finally appearing in the viscera. Recent publications indicate that Kaposi's sarcoma of the viscera and lymph nodes may precede the classical skin lesions, and may even cause death without any cutaneous manifestations whatever. The disease has a singular racial propensity for the male Jewish and Italian populations of Russia, Italy, and Poland, rarely afflicts the female sex, and terminates in death in intervals ranging from a few months to 25 years.

Incidence. The incidence and distribution of Kaposi's sarcoma, according to race, nativity, age, sex, anatomical onset, and survival, are outlined in Table I. The marked predilection on the basis of race, sex, and anatomical site is probably the most unique of its kind in the entire field of neoplasms, and must embody some specific significance which heretofore has not been developed in the literature.

The onset, in 78 per cent of patients, occurred beyond the age of 40 and the highest incidence was observed in the fifth, sixth, and seventh decades. Although the tumor is rare in adolescence, 3 patients developed their disease before the age of 20. All 3 were of Jewish or Italian extraction.

Fig. 1. Kaposi's sarcoma. Atypical, indolent lesion of 10 years' duration occurring in a young female. The tumor bears a clinical resemblance to neurofibroma.

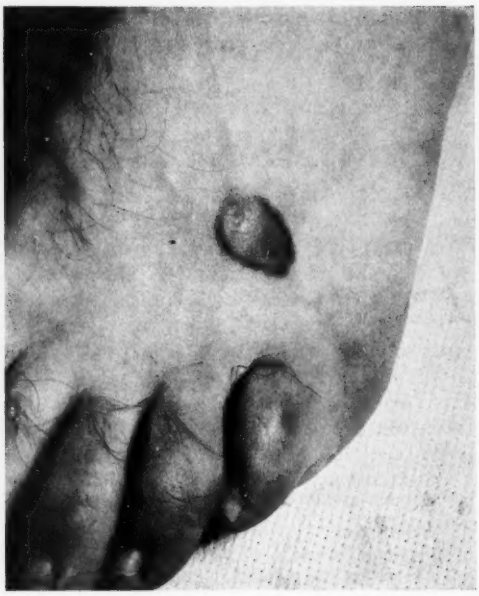


Fig. 2. Kaposi's sarcoma. The bluish-red macule is representative of the earliest or inflammatory phase of this type of growth.

As noted throughout the entire literature, the disease chiefly afflicts males. The ratio in our series was male 33 (92 per cent) and female 3 (8 per cent) as compared to a male average of 95 per cent in most reports.

Inasmuch as the majority of reported cases appeared to originate in such countries of Eastern Europe as Russia and Poland and Italy, Doerffel concluded that the dominant distribution was on a geographical rather than a racial basis. Arranging our series along both racial and geographic aspects, we found that 30 (83 per cent) were Jews and Italians, regardless of nativity, whereas arranged on a geographical basis, Eastern Europe was represented by only 74 per cent, practically all of whom were Jews and Italians. Also noteworthy was the fact that 22 per cent of our patients were American born. Such findings would support the more logical and plausible theory of a racial or biological proclivity.

Another striking propensity of Kaposi's sarcoma was discovered when the early lesions of onset were grouped according to anatomical site. In 87 per cent of patients, the earliest manifestations were detected in the skin of either lower or upper extremities, the vast majority arising in the hands and feet. Three patients first observed their tumors on the penis, and the 2 remaining patients were both females who appeared to develop their disease first in lymph nodes.

The occupations of the patients were too diversified to support the common belief that this sarcoma is peculiar to the laboring classes. However, in the present series a prevalence of occupations which kept the patient on his feet for long intervals was noted. This may be significant in view of the fact that 26 (73 per cent) of patients developed their initial tumor on the feet or legs, often with associated edema. Recent studies now tend to point to lymphedema as a factor in the genesis of angioblastic sarcomas. F. W. Stewart and Treves reported the development of lymphangiosarcoma in the edematous arms of 6 female patients whose postmastectomy elephantiasis had existed from 6 to 24 years.

TABLE I.—STATISTICAL COMPARISON OF 56 PATIENTS WITH MALIGNANT BLOOD VESSEL TUMORS INCLUDING 20 CASES OF ANGIOSARCOMA AND 36 CASES OF KAPOSI'S SARCOMA

	Kaposi's sarcoma		Angiosarcoma	
	No.	Per cent	No.	Per cent
Total cases	36		20	
Racial incidence				
Jews	16	44	14	70
Italian	14	39	1	5
Total per cent		83		75
Male female ratio				
Male	33	92	11	55
Female	3	8	9	45
Age onset*				
40 years plus		78		30
40 years minus		22		70
Anatomical onset				
Lower extremity	26	73	7	35
Upper extremity	5	14	4	20
Penis	3	8		
Lymph nodes	2	5		
Paranasal areas			5	25
Breast			2	10
Head and neck			2	10
Upper and lower extremities		87		55
Survival interval after onset. Average survival—8 years			Average survival, 2½ years	
Five year cure rate—free of disease		19†		9‡

*Highest incidence for Kaposi's sarcoma 40 to 70 years; for angiosarcoma 10 to 40 years.
†3 of 16 determinate cases.
‡1 of 11 determinate cases.

The authors speculated on a common systemic carcinogenic factor responsible not only for the angiosarcoma of the arm, but also for the prior mammary carcinoma which led to the radical mastectomy. All 6 cases demonstrated skin lesions which clinically and histologically resembled Kaposi's sarcoma. In reviewing the older literature we were able to discover 2 similar cases, both females, in whom cutaneous Kaposi's sarcoma originated in the lower extremities 9 and 29 years after the onset of massive lymphedema which resulted from infection (1, 13). In both instances, prolonged lymphedema appeared to

Fig. 3. Kaposi's sarcoma. Dark bluish nodule of granulomatous phase resembling malignant melanoma.

constitute the sole known predisposing factor inasmuch as no other primary neoplasm had previously been detected. In our opinion, the lymphangiosarcomas of the upper extremity developing in surgical elephantiasis are truly identical with Kaposi's sarcoma. In fact, Dr. Stewart so diagnosed the skin nodule submitted to him by one of us and taken from our patient included in the 6 cases mentioned.

Etiology. Since the original description of the disease there have been few contributions to a better understanding of its etiology. Acute systemic diseases, trauma, tuberculosis, and syphilis have been discarded as causative agents. Despite the typical microscopic evolution of each Kaposi's sarcoma lesion from an inflammation-like phase through a granulomatous phase into true neoplasia as described by MacKee and Cipollaro, no bacteriological or viral agent has ever been iso-

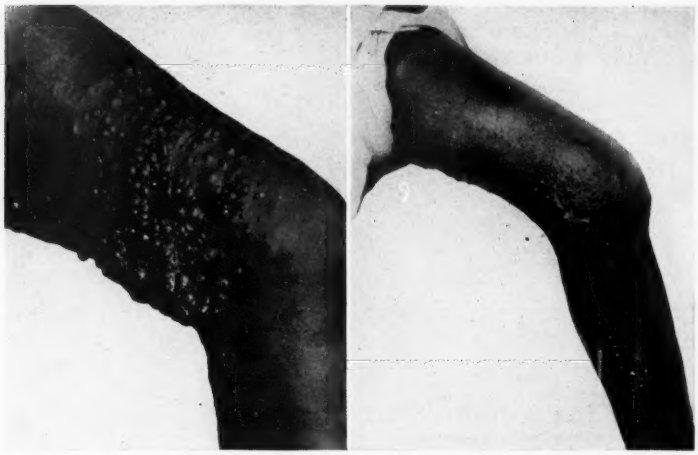


Fig. 4. Kaposi's sarcoma: a, left, Multiple bluish nodules starting to coalesce. Rare occurrence in a Negro. Lesion radiosensitive. b, Same area 2 years later. Satisfactory regression from x-ray therapy.

lated. Reinoculation of patients with their own tumor tissue by Pack and animal inoculations by Nesbitt, and by Choisser and Ramsey failed to induce tumors at the sites of inoculation. These and other experiments have somewhat nullified the concept that the tumor is an infectious granuloma.

Although a solution of the etiology is far from being settled, recent advances in the general field of carcinogenesis make it plausible now to suspect some systemic carcinogen acting upon the vascular tissues as a possible agent. Such a hypothesis would more logically explain the distinctive tendency of Kaposi's sarcoma to involve the legs bilaterally and symmetrically, and ultimately manifest itself throughout the viscera with multiple adjoining tumors in the inflammatory, granulomatous and sarcomatous phases and resembling multicentric foci rather than metastases. It is now possible to induce similar angiosarcomas in animals with injections of chemical carcinogens. Andervont, White and H. L. Stewart have induced numerous benign and malignant angiomatous tumors, several of which behaved as primary tumors of multicentric origin, with the administration to mice of azo compounds and hydrocarbons. Andervont also determined that female mice were far more susceptible to such induction than males, and clearly established the influence of sex hormones by markedly reducing tumor induction with castration and testosterone pellet implants. Further evidence of a systemic factor in humans is the early proliferative changes of Kaposi's sarcoma in liver, spleen, and lymph nodes which are far removed from the gross and obvious sarcomatous nodules in the skin and which were well described by Stats and by Tedeschi.

Undoubtedly other etiological influences are in operation, and it is essential to consider hereditary vascular dysplasias in view of the racial preponderance in Jews and Italians. Tedeschi has recently emphasized the relation of vascular dysplasias to Kaposi's sarcoma while Watson and McCarthy noted a parallel racial preponderance of Jews in their series of hereditary familial telangiectasia (Osler-Weber's disease). Cognizance must be taken of sex hormones since the incidence of male patients with Kaposi's disease is so high. In this respect Watson and McCarthy reviewed 1,056 cases with hemangioma, and demonstrated a female incidence of 65 per cent. They also observed definite growth stimulation of angiomas at the onset of pregnancy and the menarche. Further, many of the female patients with Kaposi's disease have manifested its most bizarre forms (Fig. 1),

and one of the most fulminating cases reported was an Italian female who survived only 34 days after onset of her skin lesions (28).

Clinical course. In the great majority of patients Kaposi's sarcoma originates in the skin and is so typical in appearance that it can generally be diagnosed by inspection. The initial lesion appears in the skin of the extremities as a reddened, well-demarcated macule (Fig. 2), which very slowly increases in size. In many patients, edema of the legs may precede the skin macule or nodule by long intervals. The disease appears to be more aggressive in patients with considerable vascular disturbances of the extremities.

As the insensitive, early macule progresses and becomes elevated, the color darkens to a bluish-red hue representative of the angioma-like vessel sinuses of the granulomatous phase. The bluish-red nodules in this phase may closely simulate malignant melanoma (Fig. 3). After many months, the tumors multiply in adjoining areas as a unilateral process (Fig. 4), become more cellular and less vascular, and finally attain the indurated sarcomatous phase as elevated, coalescent bluish-black plaques which are several centimeters in diameter (Fig. 5). Coincidentally the disease usually involves symmetrical areas in the other extremity in "stocking" or "glove" fashion (Figs. 6 and 7), and later extends centripetally to the trunk (Fig. 8). As the subcutaneous tissues are diffusely infiltrated by the hemorrhagic, verrucous plaques, massive edema of the extremity ensues and the tumors occasionally ulcerate and bleed. As a rule, with the exception of the tumors on the soles of the feet and the penis, pain is not associated with the disease process.

Variations of the above classical macule, nodule and plaque are not infrequent. One type evokes marked fibrous reaction and clinically resembles neurofibroma (Fig. 1). In 1 such instance the disease was rather indolent and remained localized in the leg for 10 years. Often an old lesion will regress into a flat pigmented scar in the periphery of which new nodules may develop. Still another type is composed of pink translucent nodules similar to lymphangioma. Lymphadenopathy is common in all phases of the disease, and the

Fig. 5. Kaposi's sarcoma. Final sarcomatous phase. Indurated, verrucous bluish-black plaques symmetrically disseminated.

nodes may or may not contain actual tumor cells. Ultimately, the tumors may appear in the submucosa of the entire gastrointestinal tract and lungs as friable, hemorrhagic polypoid masses. This development marks the transition into a terminal phase when exitus from exsanguination is imminent. Not uncommonly, the tonsils (Fig. 9), thoracic and abdominal lymph nodes and bone are invaded by the tumor. In our group extension to the oral cavity occurred in 3 cases, lungs in 4, bone in 2, and liver and spleen in 1 case.

Fig. 6. Kaposi's sarcoma. Symmetrical, bilateral extension in "stocking" distribution with associated edema.

Deviations from the typical cutaneous onset have been reported and it is now obvious that the tumor may originate in practically any part of the body. However, prior to Doerffel's monograph in 1932, it was generally believed that all extracutaneous lesions were metastatic inasmuch as up to that time few cases had been described in which the skin lesions were absent or had been preceded by visceral lesions. Since then, several cases have been reported with primary tumors in the viscera unassociated with any skin manifestations. Primary Kaposi's sarcoma thus far has been described in the heart (1, 6), kidney, liver, intestines (29), lymph nodes, penis (3) (Fig. 10), eye (11), ear, nose and nasopharynx (24). The trend of evidence, therefore, would suggest that Kaposi's sarcoma may be a systemic disease of multicentric origin and long duration with little tendency to metastasize, a hypothesis which is more in keeping with the frequent 10 and 15 year survival in the presence of active disease.

Spontaneous regression of individual tumors is rare and probably follows thrombosis. Long remissions also are noted and are quite deceptive to both physician and patient. One patient in the series received radium therapy for an early nodule on the sole which disappeared because regression seemed complete. Six years later he re-entered the clinic with new nodules on both feet, the hand, and a polypoid tumor in the tonsil.

Death generally results from progressive cachexia, intercurrent infection or hemorrhage from friable, bulky tumors in the gastrointestinal tract or lungs. There was x-ray evidence of pulmonary masses in 4 of our patients and 1 died of pulmonary hemorrhage. At autopsy large hemorrhagic tumors were found occluding the bronchi. In 2 other patients, septicemia and gangrene following radionecrosis were believed to be the chief cause of death.

Histopathology and pathogenesis. The histologic sections of Kaposi's sarcoma are most interesting when correlated to the clinical appearance of each lesion as it evolves from an inflammation-like macule into the "granulomatous" bluish-red nodule resembling an angioma, and into the final black plaques of frank sarcoma. If sections are made of the early macule, there is little to suggest its real sarcomatous potentialities. The vessels of the derma are dilated and surrounded by an infiltration of round and connective tissue cells. Edema and hemorrhage are minimal (Fig. 11). In the second phase or granulomatous process, the cardinal features are edema, hemorrhage, connective tissue proliferation and the growth of endothelial cells to form vessel sinuses resembling hemangiomas. This attempt at new vessel formation is abnormal and imperfect and permits the escape of red blood cells into tissues, a hemorrhagic stigma which is constant in all phases of Kaposi's sarcoma. The disease ultimately progresses into the sarcoma stage as indurated, elevated black plaques which are represented by a compound picture of spindle cell sarcoma interspersed with hemangiomatous elements and deeply stained with old blood pigment (Fig. 12). The microscopic aspects of this sarcoma serves to re-emphasize its bizarre versatility, and in some instances these wide variations

Fig. 7. Kaposi's sarcoma. Symmetrical areas of both hands involved with early edema.

may serve as an index of indolence or aggressiveness. An indolent lesion in our series was represented by scant, spindle sarcoma cells encased in fibrous tissue reaction (Fig. 13), and an intermediate type tumor by delicate cords of spindle cells interspersed with angioma sinuses (Fig. 14). Some of the most active tumors consisted of highly cellular sheets of spindle or endothelial cells which simulated melanoma, angiosarcoma or endothelioma (Fig. 15).

Controversy has centered around the pathogenesis of the sarcoma for decades and continues unabated. Although most investigators now agree that it is a sarcoma, there is a difference of opinion as to cell origin and the ability of the tumor to metastasize. All generally concede that it is of primitive blood vessel cell origin, however. Plasma cells, endothelium, perithelium, fibroblasts (28), adventitia, and vascular neuromuscular connections (21) have been variously advanced as tissues of origin.

Kaposi's sarcoma: a disease of the reticuloendothelial system? Emphasis in recent publications by Doerffel, Choisser and Ramsey, and Tedeschi, however, is on the theory that Kaposi's sarcoma is a dysplasia of the reticuloendothelial system. Evidence in support of the systemic nature of the disease and its relation to reticuloendothelial origin is increasing and has been furthered by case reports of Kaposi's sarcoma coexisting with lymphatic leucemia (7, 22), myelogenous leucemia (29), Hodgkin's disease (12, 19), and mycosis fungoides (16). Further evidence of generalized reticuloendothelial dysplasia in the patient with Kaposi's sarcoma is offered by Stats and Tedeschi who observed early microscopic deviations in tissues such as bone marrow, lymph nodes, spleen, and liver which were distant from the primary cutaneous lesions. Similar changes were also observed in our microscopic sections. In addition, 3 of our patients presented microscopic evidence of concomitant lymphoblastoma with their Kaposi's sarcoma, namely, Hodgkin's disease, Brill-Symmer's disease, and lymphosarcoma. The reticuloendothelial theory was disputed by Ewing (9, 17), who believed that Kaposi's sarcoma was a systemic disease in which a more specific structure, such as the neuromyoarterial glomus, was involved. Solution of the problem of pathogenesis is not imminent and possibly will not materialize until tissue cultures of early Kaposi tumors

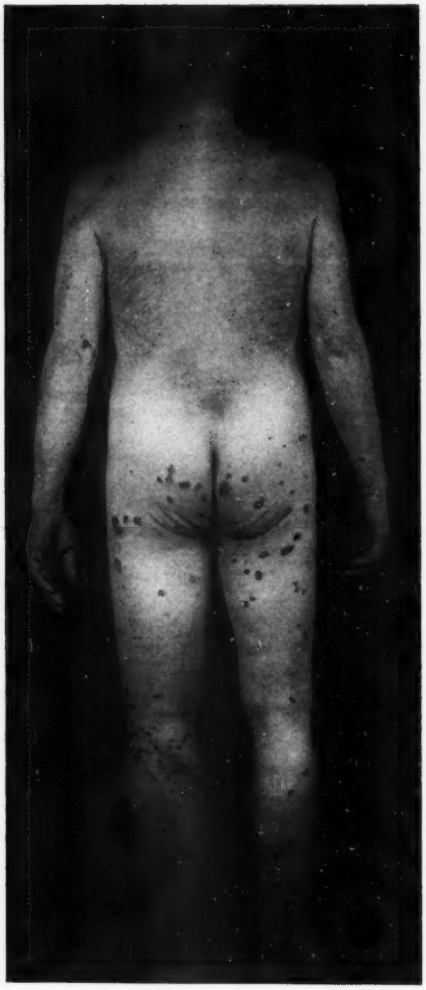


Fig. 8. Kaposi's sarcoma. Characteristic centripetal and symmetrical extension to body with edema of legs.

are investigated. A start in this direction has been made and although results are not conclusive, tissue cultures would seem to implicate primitive mesenchymal tissue as the origin (19).[1]

Prognosis. The prognosis of Kaposi's sarcoma should be guarded. It is difficult to evaluate properly the aggressiveness of the tumor in any individual case until many months have elapsed. Further complicating the entire outlook are the deceptive remissions, the bizarre variations in females and the unusual racial influences which render the fulminating types virtually unknown in Scandinavians (13), and not uncommon in Italian and Jewish patients. In general, the course is unfavorable when cutaneous tumors rapidly involve both extremities with associated edema. The outlook also is poor when lymph nodes and viscera are primarily or secondarily affected. There was no relation of the age of the patient to clinical activity of the disease.

A survey of the entire group of 36 cases revealed that a total of 26 were alive; only 7 in this group of living patients were free of disease, and 3 of these were 5 year "cures" who had been well for 5, 6, and 9 years, respectively, a definitive cure rate of 19 per cent of patients treated more than 5 years ago. Four in the group of 26 living patients, however, had survived 10, 11, 12, and 25 years with active disease. All had received radiation therapy.

In the series of patients who died with disease, 3 had survived 2 to 5 years, 5 survived 5 to 10 years and 2 lived for 15 to 20 years. One of these patients died of prostatic cancer 6 years after the initiation of therapy for Kaposi's sarcoma. The average survival interval with treatment was approximately 8 years.

Treatment. Practically all modalities of therapy were employed in the treatment of this series of patients. Enumerated, the methods were: excision with scalpel and cautery, radium pack, external and interstitial radon, contact x-ray and 100 kilovolt, 200 kilovolt and 240 kilovolt x-ray with all gradations of factors.

Although radiation therapy has been commonly recommended as the best method in most published papers to date, there has been little reference to, or experience with, the surgical treatment of Kaposi's disease. In our experience, wide surgical excision of the *early, solitary lesion* has yielded gratifying results. Analysis of the group of 7 patients free of disease revealed that 5 had submitted to excision of their lesion at onset; 1 of these patients had remained entirely well for 9 years. The 2 patients whose primary macule of the penis had been treated by amputation were well for 5

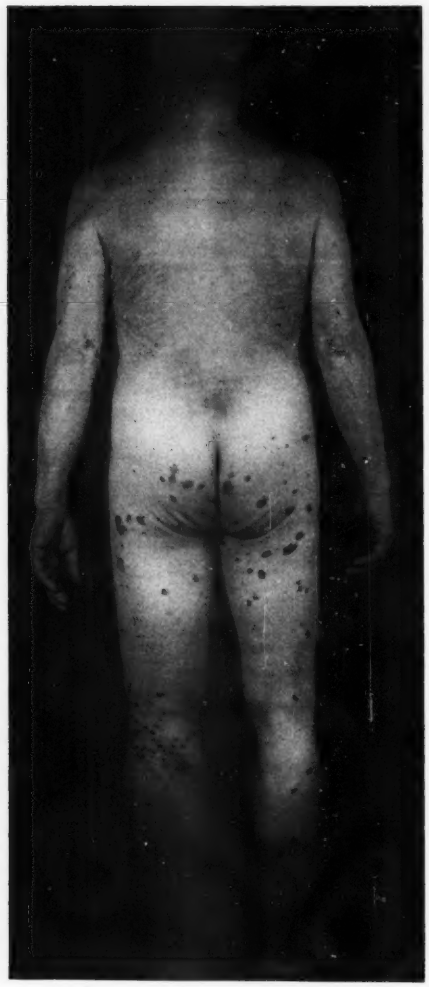
[1]Note in discussion by Doctor C. L. Spurr.

Fig. 9. Kaposi's sarcoma of tonsil: a, left, Aggressive, polypoid tumor involving tonsil and soft palate in 22 year old Italian male. b, Same area 7 months following cautery excision and intraoral x-ray therapy.

and 6 years. However, surgery is contraindicated if the tumors are extensive or multiple, or if edema is coexistent. Invariably such edema indicates deep vessel involvement and predisposes the tissues to infection and indolent postoperative defects. Occasionally, palliative cautery excision is useful for the removal of fungating tumors in the oral cavity and should be followed by intraoral x-ray therapy (Fig. 9).

Fortunately Kaposi's sarcoma is relatively radiosensitive, and irradiation is the choice of therapy if the lesions are multiple or if the process is diffusely extensive. Moreover, it has been our experience that the early, more vascular macules and nodules are far more radiosensitive than the older, indurated plaques (Fig. 4). For this reason, therefore, it is essential to educate the patient in the importance of detecting and treating the tumors in the early phases. In most instances, the early macule and nodule will completely regress with doses of unfiltered low-voltage roentgen therapy in the range of 1 to 2 threshold skin erythemas. A similar response is attainable with 1 to 2 threshold erythema doses using radium plaques at 1 centimeter distance. For larger, superficial areas, unfiltered low-voltage x-ray was also used, employing a 100 kilovolt machine, 20 to 30 centimeter target-skin distance and small portals for an average of 400 to 800 roentgen individual doses. The bulky skin plaques required larger doses with some filtra-

Fig. 10. Kaposi's sarcoma. Early primary lesion in glans penis. Treated by amputation. No evidence of recurrence 5 years later.



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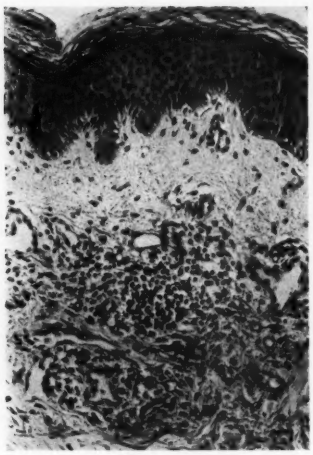

Fig. 11

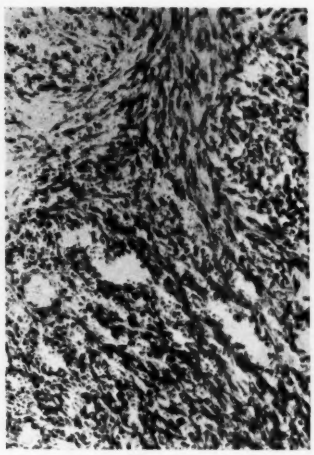

Fig. 12

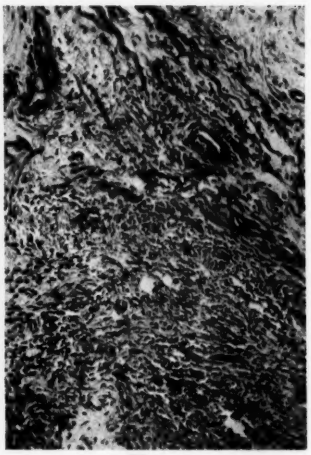

Fig. 13

Fig. 11. Kaposi's sarcoma. Section of early macule presenting process resembling inflammation or granuloma. Little evidence of its real sarcomatous nature.

Fig. 12. Kaposi's sarcoma. Section of final neoplastic phase. This photomicrograph is a typical compound picture of spindle cell sarcoma and angioma-like blood vessel sinuses.

Fig. 13. Kaposi's sarcoma. Section of indolent lesion shown in Figure 1. Scant angiomatous elements present and therefore radioresistant.

tion. All treated areas were noted on anatomical charts lest the pigmented regression be mistaken later for a new macule and radiated a second time with the hazard of late radionecrosis.

High-voltage roentgen therapy was reserved for the deep tumors which involved lymph nodes, mediastinum, lungs, abdominal viscera, and bone. In 2 patients with disease in the os calcis and tibia, the tumor regressed and pain disappeared following 200 kilovolts of x-ray therapy. Cross-fire technique was used with two small portals delivering 300 roentgens daily at 30 centimeter target-skin distance with a 2 millimeter aluminum filter for a total dose of 1500 to 1800 roentgens. With the exception of one dramatic regression in the treatment of splenomegaly, high-voltage x-ray therapy has been only fairly successful. Nitrogen mustard has proved disappointing in the few patients treated thus far (19, 24, 32).

In the final summary, it cannot be too strongly emphasized that radiation therapy be given in conservative doses if the sarcoma is extensive or if edema is present. In either event, the blood supply is generally impaired because of the very nature of the disease. Consequently, overtreatment may readily result in necrosis, infection, and gangrene. For the same reason, interstitial radiation and "blanket radiation" with large portals are hazardous.

ANGIOSARCOMA

A total of 20 cases of angiosarcoma was assembled from all the services of Memorial Hospital and included all varieties of the neoplasm. The microscopic diagnosis in each case was made either by Dr. Fred W. Stewart or the late Dr. James Ewing in simple, factual terminology. In this presentation, the authors have closely adhered to such a simplified classification in order to avoid the confusion in the existing highly differentiated terminology used to describe vascular sarcomas. We are in agreement with Kinkade that present micropathologic findings are not sufficiently conclusive to permit unequivocal, highly specific terms. Confusion probably will not clear until large series of cases are reported with well founded, factual terminology and histologically substantiated at some future time with in vitro tissue cultures.

Although angiosarcoma has been regarded as a very rare neoplasm, recent indications now point to a higher incidence than previously supposed. This information has been

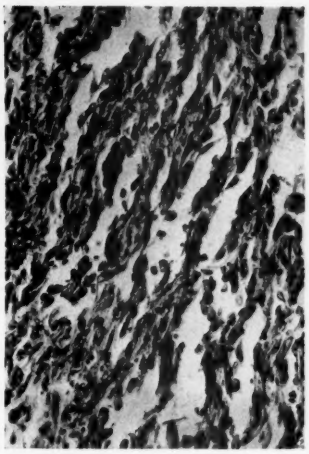

Fig. 14. Kaposi's sarcoma. Intermediate type. Angiomatous element present. Radiosensitive tumor.

Fig. 15. Kaposi's sarcoma. Sheets of solid cells simulating other types of sarcoma.

well developed by Kinkade, who reviewed the literature from 1934 to the present time. The true incidence is not known, but it is noteworthy that at the Memorial Hospital in a 10 year period, 1,056 cases of benign angioma were reported (30) and are supplemented in this report, over the same period, with 20 angiosarcoma and 36 Kaposi's sarcoma cases. In addition, 27 specimens of angiosarcoma were also submitted to Dr. Stewart and Dr. Ewing from other sources over the same 10 year interval but are not included in this series.

Angiosarcoma, when studied comparatively with Kaposi's sarcoma, revealed several interesting parallels in clinical incidence, distribution and behavior. A similar racial predilection in the Jewish and Italian populations, for example, was noted also to occur in angiosarcoma. In the total of 20 angiosarcoma cases, 14 were Jewish and 1 was Italian, a total of 75 per cent as compared to the 83 per cent total in Kaposi's disease. Angiosarcoma, however, unlike Kaposi's sarcoma, appeared to afflict both sexes equally; 11, 55 per cent, were males and 9, 45 per cent, females. It occurred more frequently in childhood and youth. Whereas 78 per cent of the patients with Kaposi's sarcoma developed the disease after the age of 40, 14 or 70 per cent of the angiosarcoma cases had their onset before the age of 40. A majority of 45 per cent occurred in the ages between 10 to 30 years. The highest incidence in the group of patients with Kaposi's sarcoma was in the fifth and sixth decades.

The anatomical distribution of the primary lesion of angiosarcoma was more diverse than that of Kaposi's sarcoma but nevertheless showed the same tendency to occur on the extremities. However, it developed generally as a tumor of the soft parts rather than skin. Approximately 55 per cent of the angiosarcomas occurred on the extremities as compared to 87 per cent of the primary Kaposi's sarcoma. The exact anatomical distribution was: lower extremity 7, 35 per cent; paranasal region 5, 25 per cent; upper extremity 4, 20 per cent; breast 2, 10 per cent; head and neck 2, 10 per cent. A similar propensity for extremities was found in the 27 additional submitted specimens and in the series reported by Schmidt.

Little is known about the etiology of angiosarcoma except in a fragmentary way as described above in the reports of Andervont, F. W. Stewart and Treves, and White and H. L. Stewart. Trauma, verified by medical records, was a declared factor in onset in 3 of our patients, and in 2 cases reported by Stout. One, therefore, is logically compelled to consider the genesis of angiosarcoma from the granulation tissue capillaries of traumatized areas. In 2 of our patients, aged 2½ and 16 years respectively, medical records attested to the appearance of

Fig. 16. Angiosarcoma of the hand and wrist: a, above, Lymphangiosarcoma. Photograph of tumor 4 months following trauma to the area. b, Hemisection of amputated arm demonstrating extent of the tumor.

a mass in the injured area within 2 months. Both expired within 2 years of metastases from a primary angiosarcoma and granulation tissue angiosarcoma of the hand and the temple, respectively. The third patient presented a similar sequence and submitted to amputation of the arm for a sarcoma of the hand (Fig. 16). The pathogenesis of angiosarcoma rests rather statically in a turmoil of controversy which is reflected directly in the welter of confusing histological classifications. Tumor cells explanted in tissue cultures probably will solve the dilemma since they "grow in a manner representative of their origin" and may determine if the source is in mesenchyme, "angioblastic cells," "pluripotent cells," or differentiated vascular tissue.

Grossly, the angiosarcomas demonstrated little resemblance to Kaposi's sarcoma in that the primary lesion usually occurred as a solitary, firm, bulky tumor situated deep in soft tissue (Figs. 16, 17, and 18) circumscribing resistant tendons and bone but invading muscle, fat, and veins (Fig. 19). Growth, as a rule, was moderately rapid and hemorrhagic cyst-like cavities, necrosis and mucoid degeneration was common. Resultant pressure symptoms caused pain and tenderness which was notably less in Kaposi's sarcoma. On the other hand, skin recurrences behaved similarly to those in Kaposi's sarcoma (Fig. 20) and were often associated with edema.

The microscopic diagnoses were restricted to a simple descriptive terminology which included the terms angiosarcoma, angiomyosarcoma, lymphangiosarcoma, malignant angioendothelioma, malignant metastasizing angioma and granulation tissue sarcoma. The histological diagnosis was reconfirmed in many of the patients by repeated biopsies, long clinical follow-ups, and necropsies. Variations in the microscopic picture are numerous and complex, and diagnosis is difficult. As the sarcoma characteristically progresses into anaplastic phases, it is often necessary to review the earlier differentiated sections and resort to silver reticulin stains. The individual cells may be fusiform, rounded, or polygonal. They may simulate cavernous vascular sinuses (Fig. 21), the pseudo rosettes of Ewing's tumor (Fig. 22), or may form solid sheets of cells (Fig. 23). Occasionally they exist in a delicate framework of reticulin fibers (Fig. 24) which can be closely duplicated by metastatic clear-cell renal adenocarcinoma. Microscopically, three angiosarcomas were found to resemble Kaposi's sarcoma. One of these, a recurrent lymphangiosarcoma, also simulated Kaposi's disease clinically (Fig. 20).

The clinical course of the angiosarcoma patients varied entirely from that of Kaposi's sarcoma and was determined by the type of sarcoma, location, and aggressiveness. The tumors in the extremities were characterized by rather rapid onset and growth, bulky tumefaction, pain, and associated edema. Onset of angiosarcoma in the nasal cavity and sinuses generally was accompanied by epistaxis, headache, nasal obstruction with gradual swelling, and displacement of the eye, and destruction of bone. The sarcomas in the breast developed rapidly as large tumors and showed aggressive growth. Death in most cases ensued within 3 years from metastases to lungs, viscera, bone, and lymph nodes.

The therapy of the patients in our series was diverse and varied according to the site and stage of disease. In general, the majority received extensive x-ray or radium therapy with

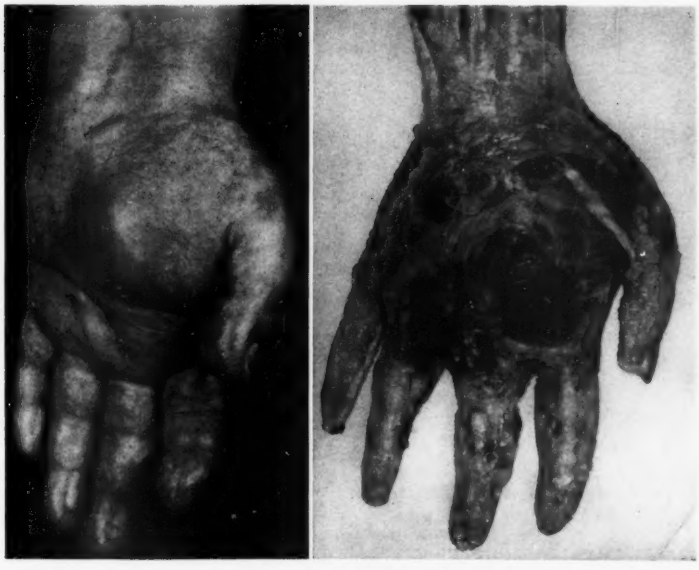

Fig. 17. Angiosarcoma of the hand: a, left, Bulky, firm, fixed tumor of soft parts. b, Hemisection revealing hemorrhagic nature and extent of the sarcoma.

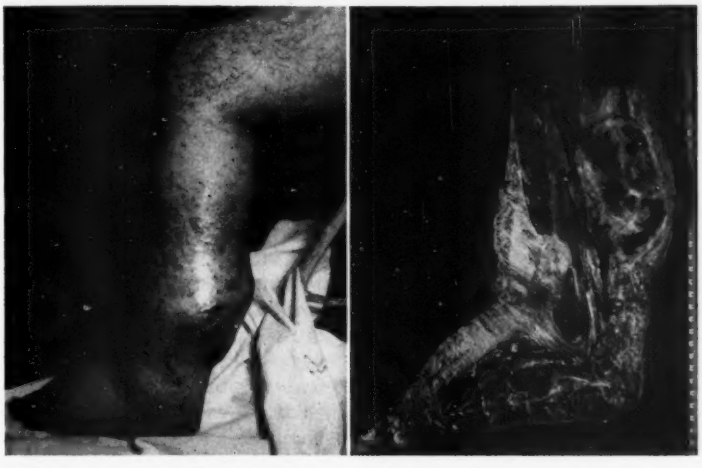

Fig. 18. Angiosarcoma of the leg: a, left, Lymphangiosarcoma originating in the site of a lymphangioma which was excised and irradiated 12 years previously. b, Hemisection of amputated leg.

or without radical surgery. Definite conclusions have been formulated but are complicated by several patients who had been previously treated and were admitted in advanced stages of disease.

Considering first the total of 11 patients with sarcoma of the extremities, it was noted that 9 had previous local excision elsewhere. Amputations were performed on 4 patients but analysis revealed an average delay of 14

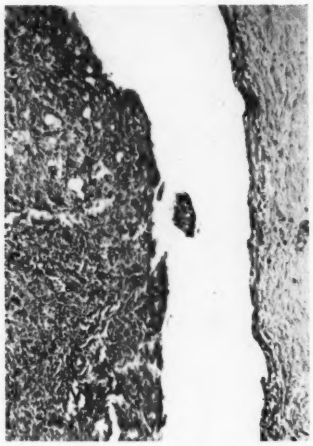

Fig. 19. Angiosarcoma. Section of gross invasion of popliteal vein by sarcoma of the leg. Note lumen of vein in the left of the photo.

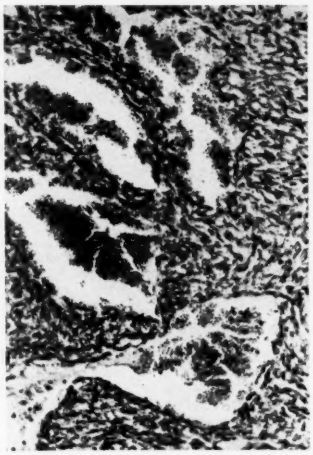

Fig. 21. Angiosarcoma in bone. In this photomicrograph the presence of cavernous vascular sinuses are to be observed.

months after local excision before they were referred here for radical surgery; 3 of these patients died and 1 was alive and well a few months after surgery. The 7 remaining patients of this group were delayed on an average of 17 months before referral and admission and in them the sarcomas were moderately advanced. All 7 patients in the group received x-ray therapy and 3 were also treated by wide excision of the tumor. In this group of 7 patients, 4 expired, 1 was alive and well for 1 year, 1 was alive with residual sarcoma 18 months, and 1 was lost to follow-up. Although the primary and metastatic lesions were moderately radiosensitive, there were no 3 year or 5 year "cures" among the patients treated by irradiation. Although irradiation did not appear to prolong life, it added materially to the comfort of patient by palliation of pain.

Fig. 20. Angiosarcoma of the thigh. Lymphangiosarcoma developing 15 years after the excision and irradiation of an angioma in the same area. Skin recurrences resemble Kaposi's sarcoma.

In conclusion, it is our opinion that irradiation should be reserved as a *palliative* procedure for advanced cases. Local excision or wide excision of the tumor is definitely contraindicated, not only because of the danger of dissemination, but also because the procedures are inadequate and serve to delay the real *curative* course of therapy which is prompt amputation. Furthermore, since 45 per cent of the determinate cases developed lymph node metastases, it is logical to consider interscapulothoracic amputation, hip joint disarticulation with deep iliac node dissection or hemipelvectomy in order to encompass metastases in axillary, inguinal, and iliac nodes.

The second most common tumor site in the series was the nasal cavity and sinuses (Table I). The 5 patients in this group constituted 25 per cent of the series. Therapeutic results here were more encouraging due probably to the low grade nature of the tumors and a shorter interval of delayed admission. The youngest patient, 13 years old, presented an

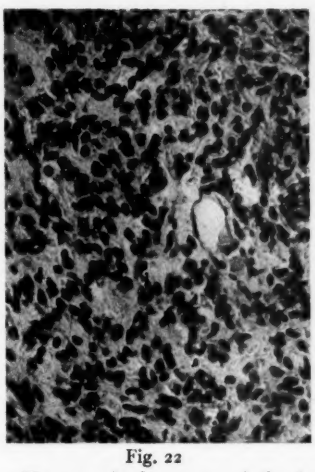

Fig. 22

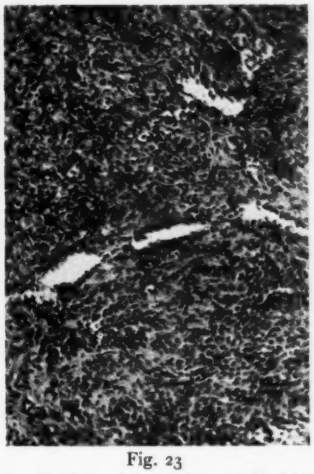

Fig. 23

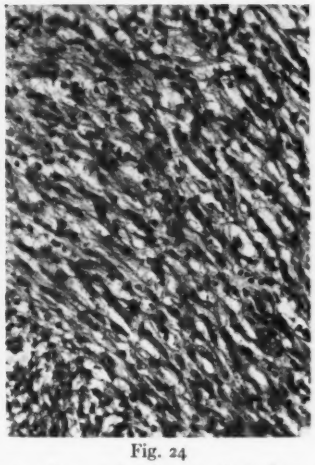

Fig. 24

Fig. 22. Angiosarcoma of the breast. Section with pseudorosettes resembling Ewing's tumor.

Fig. 23. Angiosarcoma. Section showing solid sheets of cells bearing resemblance to Kaposi's sarcoma. Photomicrograph of biopsy specimen taken from patient shown in Figure 20.

Fig. 24. Angiosarcoma of the antrum. Recurrent lesion losing relation to vessels.

aggressive angiosarcoma of the paranasal area which involved nares, orbit, and sinuses and was radioresistant (Fig. 25). Intensive x-ray therapy was ineffective and the patient was lost to follow-up. Again, hereditary racial predilections must be considered since the boy was Jewish and had a tragic family history of cancer. His 2 year old sister died with sarcoma of the buttock and his father and mother died with cancer of the oral cavity and esophagus. The oldest patient, age 71 years, was treated with 3,250 millicurie hours of intranasal radium for angiosarcoma of the posterior nasal cavity, and was free of disease 5 years later. A third patient, age 56 years, with a radioresistant polypoid sarcoma of the ethmoids was alive with disease 2 years after intensive x-ray treatment. The 2 remaining cases were young women, 22 and 29 years of age. The older patient delayed medical consultation 18 months and responded poorly to radical antrotomy and radiation. She survived 4 years with disease. The 22 year old patient was free of disease 3 years after high voltage x-ray for capillary angiosarcoma of the nares.

The onset of disease in the latter two young women was particularly interesting because it occurred during pregnancy in both cases. One of the authors (30) has previously observed similar hormone growth stimulating phenomenon of hemangiomas during pregnancy and the menarche. Recent investigations appear to relate such vascular phenomena during pregnancy to high estrogen levels (4).

Angiosarcoma of the breast was noted in 2 young female patients. One patient, age 21, presented the rare type of capillary angiosarcoma or "metastasizing hemangioma" (10, 27) which microscopically may resemble a benign, orderly hemangioma but clinically behaves as a sarcoma. This patient developed a mass shortly after a minor episode of breast trauma. The tumor was widely excised by her physician and reported as a benign angioma. Three years later she suddenly developed hemoptysis and died within a year. Autopsy revealed metastatic capillary angiosarcoma in the lungs, omentum, mesentery, and ovaries. The second patient, age 23, noted a rapidly growing mass in the breast after 2 episodes of trauma to the area. The mass was locally excised twice by her physician and a radical mastectomy finally performed 4 months after onset. Postoperative x-ray therapy was ineffective for local recurrence and the patient died of pulmonary metastasis within 1 year after onset.

Fig. 25. Angiosarcoma of antrum. Radioresistant lesion in a 13 year old boy. (Courtesy Dr. Hayes Martin.)

In the final group, there were 2 patients with primary angiosarcomas on the temple and the neck. In 1 patient, a 2½ year old girl, a granulation cell sarcoma developed in the site of a hematoma of the temple 1 month after injury from a fall. The tumor was excised by her physician 4 months after onset and the biopsy reported as granulation cell sarcoma. X-ray therapy was given over the region 1 month later. Skin recurrence and cervical node metastases quickly ensued and were also subjected to radiation therapy with good regression. The patient expired 2 years after onset, and postmortem examination demonstrated metastases to cervical, thoracic, and abdominal lymph nodes and bone. The second case, a 34 year old male, developed a tumor of the upper neck which was originally excised and again removed on two subsequent occasions when it recurred 8 and 10 years later. The tumor

Fig. 26. Angiosarcoma originating in a postmastectomy lymphedematous arm 10 years following radical mastectomy.

finally recurred 20 years after onset and only then was biopsy made and angiomyosarcoma diagnosed. The patient was alive with disease when examined 7 months later. Presumably, the early recurrences were those of a benign tumor which finally evolved into a true sarcoma after a long latent interval.

Contrary to the generally accepted opinion, there is evidence in our series that benign angiomas can and do progress into angiosarcoma, particularly following radiation therapy. Three patients with benign angiomas, verified by biopsy, later developed angiosarcoma in the identical regions. One patient, a 33 year old female, had an angioma of the thigh treated elsewhere by x-rays, at the age of 15. It recurred 15 years later as an angiosarcoma (Fig. 20). The remaining 2 patients, both age 35, submitted to excision of a benign lymphangioma of the leg 4 years and 12 years prior to the final biopsy, which was lymphangiosarcoma in both instances (Fig. 18). Both patients had received postexcisional x-ray therapy over the scars. Cahan and associates have similarly reported the development of osteogenic sarcoma in irradiated bones 6 to 2 years after radiation therapy for benign bone tumors.

In review, angiosarcoma proved to be a more lethal disease than Kaposi's sarcoma and terminated in death in a shorter time. The

average survival interval from the onset to time of death was 2½ years for angiosarcoma as compared to 8 years for Kaposi's disease. In the patients with Kaposi's sarcoma, the 5 year cure rate was 19 per cent; however, several patients were alive with disease for 10 to 25 years. The 5 year cure rate for the patients with angiosarcoma was 9 per cent and the 3 year cure rate was 17 per cent.

In so far as possible, we have avoided the use of the term "hemangioendothelioma." It is an excellent and legitimate histological term. However, we deem it opportune to emphasize the dangers in the *clinical usage* of the term "hemangioendothelioma" since pathologists commonly employ it to denote *both* a benign and a malignant type of angiomatous tumor. We have examined several children in recent years who narrowly escaped amputation when a benign hypertrophic hemangioma, described elsewhere in the literature by one of the authors (30), was microscopically diagnosed as "hemangioendothelioma" and sarcoma thereby implied. To the vast majority of clinicians, "hemangioendothelioma" connotes a highly malignant sarcoma. It is our hope to clarify the issue in a subsequent paper.

In passing, we have included 2 additional patients with lymphangiosarcoma occurring in the postmastectomy lymphedema of the arm who were admitted too late for inclusion in our series. One was a 67 year old white female who developed massive lymphedema of the right arm 10 years ago following radical mastectomy for carcinoma. Several months ago she noted the appearance of an elevated, firm, purplish-blue skin lesion in the skin of the upper arm. Recently, similar satellite nodules have appeared over the entire arm and are growing rapidly (Fig. 26).[1]

Another patient, a multiparous woman 59 years of age, had a radical mastectomy done for an infiltrating duct carcinoma, grade III, without metastasis to axillary lymph nodes. Ten years later when 69 years old, there was no evidence of recurrence in the scar, and no enlargement of supraclavicular lymph nodes. The entire ipsolateral arm was livid, swollen and lymphedematous from wrist to shoulder. Innumerable firm, tender bluish-purple nodules were scattered throughout the skin of the forearm and elbow; these masses measured 3 millimeters to 1 centimeter in diameters. An interscapulothoracic amputation was done. The report of the pathologist was lymphangiosarcoma developing in the arm of surgical elephantiasis. Three years later there has been no recurrence. The swollen arm had developed immediately after the radical mastectomy.

[1]Clinical record from the General Tumor Clinic, Highland-Alameda County Hospital, Oakland, California.

SUMMARY

1. A comparative survey of 20 cases of angiosarcoma and 36 cases of Kaposi's sarcoma is presented. Several new conclusions are developed. An attempt has been made to clarify the great confusion existing in the study of malignant blood vessel tumors.

2. Definite predilections in race, sex, and anatomical onset are noted in Kaposi's sarcoma. Among our patients 82 per cent are Jews and Italians, 92 per cent are males, and 87 per cent had their onset on the extremities. The disease is bizarre or fulminating in females. Similar predilections are noted in the patients with angiosarcoma.

3. Evidence gathered from our series and from the literature has provisionally implicated racial predisposition and a systemic factor, possibly hormonal, in the development of malignant vascular tumors.

4. Three added cases of Kaposi's sarcoma with coexisting lymphoblastoma are reported.

5. Radiation therapy of Kaposi's sarcoma is evaluated and a new surgical approach to the early lesions is presented.

6. Trauma appears to be directly involved in the development of angiosarcoma in 3 of our patients and was suspected in 2 patients with angiosarcoma of the breast.

7. Angiosarcoma has been observed to develop from irradiated benign angiomas in 3 patients after long intervals.

8. Prompt radical amputation is deduced to be the only curative therapy for angiosarcoma of the extremities. A majority of our patients were withheld from amputation on an average of 17 months by temporizing procedures of inadequate excision or irradiation.

9. X-ray and radium therapy has a definite place in the curative treatment of angiosar-

coma of the nasal cavity and paranasal areas. It was indispensable in the palliation of the advanced or inoperable angiosarcomas in general.

10. The 3 year cure rate in the angiosarcoma group is 17 per cent; the 5 year cure rate 9 per cent. Average survival interval was 2½ years.

11. The definitive 5 year cure rate of Kaposi's sarcoma is 19 per cent. The average survival from time of onset was 8 years. However, several patients are alive with the disease from 10 to 25 years.

12. Two patients are added to the recent literature which has described a new disease entity in which lymphangiosarcoma originates in the massive arms of women with postmastectomy lymphedema.

13. Clinicians are strongly cautioned against the acceptance of the ambiguous term "hemangioendothelioma" which is being commonly used to describe a specific type of *benign* cellular hemangioma in children. The term implies sarcoma and has undoubtedly led to needless radical surgery in many instances. It should be employed only to designate a specific type of angiosarcoma.

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A MEDICAL CORPS FOR THE ARMED SERVICES

ONCE more with the steadily approaching specter of a general world war, there is a stockpiling of all the commodities of combat against the day of eventual full emergency. Airplanes, tanks, atom bombs, food, combat personnel; in fact, all the armamentarium is being assembled for readiness. Unheeding an experience no more than five years past, there is every evidence that the medical profession is to be regarded as a commodity which can be stockpiled and expended extravagantly. In fact, high command military officials, speech-making congressmen and glib, syndicated columnists support the demands for doctors by charges which intimate disloyalty and ingratitude on the part of physicians. Unfortunately, these statements have been supported by spokesmen for the medical profession.

The United States has never been engaged in any war wherein the medical profession has deported itself in any way except to the benefit of the wounded, the honor of the nation and to its own great credit. Moreover, in the minds and hearts of the doctor soldiers, the importance of their contributions has always been in that order. It was generally conceded at the end of World War II that the care rendered the wounded by American doctors was the best in the history of any war and certainly better than the average care received by the casualties of any other nation. All of this was done with a concerted effort by a profession whose principles are those of saving life rather than inflicting death. There is no instance which would indicate that the individual doctor is any less loyal to the support of his government than any other citizen and there is abundant evidence that as a profession physicians have been an outstanding example of group patriotism.

Now, however, doctors are to be drafted into the military services. It would seem appropriate to examine some of the circumstances surrounding the precipitate legislation which has been hurried through the Congress and which can, and may lead to the peace time regimentation of doctors without the necessity of passing a bill for socialized medicine.

It has been stated that those young doctors who were in medical school during World War II in either Army or Navy educational programs owe their education to the government. It has never been pointed out, however, that the majority, if not all, of those medical students had chosen medicine as their life's work and were either enrolled in medical schools or were engaged in their premedical education. They were inducted into the Army or Navy and, *at the convenience of the government*, were ordered to units which insured the continua-

tion of their studies and the production of doctors necessary to the war effort. Young men were given intelligence and aptitude tests which were designed to convince the Army and Navy that they were suited to become doctors. What prevented the assignment of these men to combat units which congressmen and columnists have indicated would have been a more honorable service? The evidence of the beliefs of these gentlemen lies in their columns and in their revisions of the selective service law. It is undoubtedly a fact that every medical student during the period of World War II would have become a doctor upon his own initiative and by his own mental and financial efforts. Why, then, should this group of young doctors be stigmatized by what is apparently and admittedly class legislation? Other men were trained in other fields during the past war and upon their return to civilian life have taken advantage of that training. It is right that this be so, but do they owe that training to the government which ordered them to suit the needs of the military? Did they not serve honorably and well?

Why is it that the medical profession has not volunteered in numbers sufficient to make a draft unnecessary? The answers lie within the organization of the medical corps of the Army, Navy and Air Force. Is it unreasonable to assume that their attitude may have been colored by first hand knowledge of the frustrations, stupidities and inefficiency of direction suffered just a few years ago? Doctors were justifiably irritated by the inanities of plans and training programs, forced upon them, not through reason, but by superior rank and written rule to support that rank. They remember not being allowed to schedule operations because upon that morning all doctors must devote themselves to the inspection of latrines, the motor pool and the enlisted men's day room. They remember being ordered to leave their wards of sick and wounded men to act as military police for two weeks, before being allowed to come up for promotion in rank. During those two weeks, instead of treating battle wounds, malaria, or hepatitis, they remember making the rounds of houses of prostitution to rout out the wayward G.I., or they trapped the unwary soldier on the street for not saluting properly, or they caught him out on pass and made him roll down his sleeves or jerk up his tie. Might not these be examples of the extravagant use of the medical profession?

It is also difficult for the civilian doctor to understand why the Navy, Army and Air Force insist upon having separate and distinct hospitals under their own command. It is hard for the surgeon to understand why a fractured femur, regardless of whether it was sustained in ground combat, on a ship, or in an airplane accident, should not be treated in the same manner in one hospital to which any soldier, marine, sailor or airman might be sent. It is difficult for the civilian doctor to understand why unification, not upon paper but actual unification, of the medical services to the wounded cannot be effected. The medical profession knows that the office of the Medical Director to the Department of Defense is not unification of the medical services. There would seem to be only two answers possible which would explain the failure to implement the recommendations submitted for unification of the medical services. One answer is political expediency, because it is obvious that the President of the United States, as Commander in Chief, could put such a unification plan into effect immediately. True, it is, that he would have to dismiss the present Surgeons General of the Army, Navy and Air Force. The second reason is that command of separate hospital installations means command of personnel and the latter means the distribution of

rank according to tables of organization. Rather simply stated, three separate medical services mean more colonels and generals.

Finally, the attitude of the civilian doctor toward the present military situation may reflect his concern over the fact that he knows that never again can medical talent be squandered in time of war. Atomic all-out warfare means medical care for the entire civilian population as well as those in combat. The thoughtful doctor knows that the abilities of his profession, private and public hospital facilities, medical supplies, indicated elective surgical procedures; in fact all medical care in this country will have to be rationed circumspectly. He knows that in the hospitals of the Veterans Administration there are beds occupied by patients with non-service connected disabilities which could be used for the present Korean casualties. He knows that they would receive the highest type of medical care in the several Veterans Hospitals associated with medical schools; he knows that men whose wounds require amputation of an extremity should be flown immediately to those Veterans Hospitals wherein they may receive the benefits of all of the research and investigations which have been carried on in recent years upon prosthetic appliances and rehabilitation of the amputee; he knows that the Army, Navy and Air Force should have staffed and organized their hospitals by the part-time services of the civilian doctors in peace time so that the transition to war could have been smooth and uninterrupted; he knows that this was not done because a doctor in civilian clothes does not fulfill the requirements of a table of organization for command purposes; he knows that the Veterans Administration enrollment, organization and utilization of the civilian medical population has been successful.

There should be a Medical Corps for the Armed Services and hospitals for the sick and wounded from any branch of the armed services. Indoctrination of doctors into the combat field peculiarities of ground, sea or air fighting is not an insurmountable task under such a service. It would not be difficult to create a pool of regular armed service doctors who would be attracted to such a career of medical and public health administration and would be competently trained to co-ordinate the efforts of the civilian doctor brought into the emergencies of war. It would be far better for efforts to be expended toward such a goal than to initiate draft legislation which is another step toward the complete regimentation of the American people. LOYAL DAVIS.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN the comprehensive monograph *Shock and Allied Forms of Failure of the Circulation*[1] the author has included all forms of shock which he defines as "a state involving the entire organism, characterized by a generalized impairment of the circulation and caused by any form of stress or injury which reduces the output of blood from the left ventricle of the heart to a level below that needed for normal cellular function and metabolism." The broad scope of his definition permits him a discussion of the many forms of shock-like states which often are overlooked. These are well presented in orderly fashion and with attention to historical background.

The physician and student alike will find a full and unbiased discussion of a number of the controversial aspects of shock. Presented in detail are many of the disturbances in the economy of the individual and an evaluation of how these disorders may be corrected or prevented. Illustrative material is used to good advantage both graphically and as case illustrations.

Traumatic shock is discussed in terms of general physiology and a number of the theories relating to pathogenesis are presented and their limitations pointed out. In fact, the strength of this monograph lies in its comprehensive coverage of the biochemical and physiological aspects of the shock syndrome. The importance of correcting any anoxia as well as the hypotension of shock is emphasized.

This book was written in such a manner that the commonly encountered shock-like states observed in the various fields of medicine can be approached from the viewpoint of the reader's interest. This serves its purpose well as a ready reference, but makes inevitable some repetition which the author has kept at a minimum.

The book is well printed and bound, and its importance as a reference as well as a text makes it a desirable monograph for the surgeon, anesthetist, resident, intern, and student. J. GARROTT ALLEN.

THE second edition of *Fetal and Neonatal Death*[2] (the first edition was published in 1940) is still the best digest of this subject to appear to date. There is an amazing amount of material presented in a small volume. Drs. Potter and Adair had the especial interest in mind of each branch of the medical sciences dealing with fetal and neonatal death.

The development of the normal fetus and infant is reviewed from the time of conception through the fetal and neonatal period, thus a basis for comparison with the abnormal and pathologic is formed. Technique of the postmortem examination of the newborn is presented. Special training in infant pathology is essential for the detection of the more subtle causes of death. Stress is placed upon the importance of complete examination of the placenta.

The causes of death of the fetus are enumerated and maternal factors are discussed. The chapter on special pathology of all the systems is quite complete and the abnormal findings will be of interest to all clinicians since many of these are compatible with life, provided the deviation is not too extreme. The concluding chapter indicates the progress made in fetal and maternal salvage in the United States. It is encouraging to review the effect of the efforts made toward the goal of the "irreducible minimum" in infant and neonatal deaths. Throughout, complete tables are presented. AUGUSTA WEBSTER.

AN excellent demonstration of the technique of visual education is demonstrated in *Hemorrhagic Disorders*[3] by Aggeler. The material consists of illustrations and data presented as a scientific exhibit. The book is divided into 4 sections: (1) physiology of hemostasis, (2) hemostatic tests, (3) hemorrhagic disorders, and (4) therapeutic agents and procedures. The print is large, and the illustrations and charts are excellent.

The student and practicing physician will find this an excellent review of a subject which in the past has been difficult to learn and, particularly, to remember. The hematologist will probably find this volume of little practical use except perhaps as an aid in his teaching. The book is of necessity dogmatic, and some hematologists will disagree with some of the statements made; for example, that a splenectomy should never be done in the presence of secondary thrombocytopenic purpura.

JOHN A. MART.

[1] SHOCK AND ALLIED FORMS OF FAILURE OF THE CIRCULATION. By H. A. Davis, M.D., C.M., F.A.C.S. New York: Grune & Stratton, 1949.

[2] FETAL AND NEONATAL DEATH. A Survey of the Incidence, Etiology, and Anatomic Manifestations of the Conditions Producing Death of the Fetus in Utero and the Infant in the Early Days of Life. By Edith L. Potter, M.D., Ph.D., and Fred L. Adair, M.D. Chicago: The University of Chicago Press, 1949.

[3] HEMORRHAGIC DISORDERS; A GUIDE TO DIAGNOSIS AND TREATMENT. By Paul M. Aggeler, M.D., and S. P. Lucia, M.D. Chicago: The University of Chicago Press, 1949.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

LE CANCER DU CORPS UTÉRIN. Published under the direction of P. Chalnot with collaborators. Paris: L'Expansion Scientifique Française, 1950.

CLINICAL ELECTROCARDIOGRAPHY. By Francis F. Rosenbaum, M.D., edited by Henry A. Christian, A.M., M.D., LL.D., Sc.D., (Hon.), M. A. C. P., Hon. F.R.C.P. (Can.) D.S.M. (A.M.A.). New York: Oxford University Press, 1950.

WORLD SURGERY 1950. By Stephen A. Zieman, M.A., M.D., F.A.C.S., F.I.C.S. Philadelphia, London, and Montreal: J. P. Lippincott Co., 1950.

ASPHYXIA NEONATORUM. ITS RELATION TO THE FETAL BLOOD, CIRCULATION AND RESPIRATION AND ITS EFFECTS UPON THE BRAIN. By William F. Windle, Ph.D. Springfield: Charles C Thomas, 1950.

MIDWIFERY. PRINCIPLES AND PRACTICE FOR PUPIL MIDWIVES, TEACHER MIDWIVES AND OBSTETRIC DRESSERS. By R. Christie Brown, M.B., M.S., F.R.C.S., F.R.C.O.G., Barton Gilbert, B. Sc., M.D., F.R.C.S., F.R.C.O.G., and Richard H. Dobbs, M.D., F.R.C.P. Baltimore: The Williams & Wilkins Co., 1950.

MANAGEMENT OF PERIPHERAL ARTERIAL DISEASES. By Saul S. Samuels, A.M., M.D. New York: Oxford University Press, 1950.

MANUAL OF RHEUMATIC DISEASES. By W. P. Holbrook, M.D., and D. F. Hill, M.D. Chicago: The Year Book Publishers, Inc., 1950.

LIGHT THERAPY. By Richard Kovacs, M.D. Springfield: Charles C Thomas, 1950.

CHIRURGISCH-GYNAEKOLOGISCHE GRENZFRAGEN. By Prof. Dr. Herbert Uebermuth. Leipzig: Georg Thieme, 1950.

THE AMERICAN RED CROSS. A HISTORY. By Foster Rhea Dulles. New York: Harper & Brothers, 1950.

HUMAN EMBRYOLOGY AND MEDICAL STUDENTS. By S. R. Nair, M.D. Bombay: The Popular Book Depot, 1950.

A TEXTBOOK OF GYNECOLOGY. By Arthur Hale Curtis, M.D., and John William Huffman, M.D. 6th ed. Philadelphia and London: W. B. Saunders Co., 1950.

GASTRITIS, ULKUS AND KARZINOM. By Prof. Dr. J. Buecker. Stuttgart: Georg Thieme Verlag, 1950.

DEVIATIONEN DER BEBAERMUTTER UND SCHEIDE. By N. N. Sergejew. Regensburg: Josef Habbel, 1950.

CLINICAL THERAPEUTIC RADIOLOGY. By U. V. Portmann, M.D. Edinburgh, New York, Toronto: Thomas Nelson & Sons, 1950.

YOU'LL LIVE THROUGH IT; FACTS ABOUT THE MENOPAUSE. By Miriam Lincoln, M.D., F.A.C.P. New York: Harper & Brothers, 1950.

A TEXT-BOOK OF X-RAY DIAGNOSIS. Edited by S. Cochrane Shanks, M.D., F.R.C.P., F.F.R., and Peter Kerley, M.D., F.R.C.P., F.F.R., D.M.R.E. Vol. 4, 2d ed. Philadelphia and London: W. B. Saunders Co., 1950.

WILLIAMS OBSTETRICS. By Nicholson J. Eastman. 10th ed. New York: Appleton-Century-Crofts, Inc., 1950.

PRACTICAL GYNECOLOGY. By Walter J. Reich, M.D., F.A.C.S., F.I.C.S., and Mitchell J. Nechtow, M.D. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1950.

BUCHANAN'S MANUAL OF ANATOMY. Edited by F. Wood Jones, D.Sc. (Lond., Adelaide and Melb.), M.Sc. (Manch.), M.B., B.S.(Lond.), F.R.S., F.R.C.S. (Eng.), F.R.A.C.S. 8th ed. Baltimore: The Williams & Wilkins Co., 1950.

TECHNIQUES IN BRITISH SURGERY. Edited by Rodney Maingot, F.R.C.S. Philadelphia, London: W. B. Saunders Co., 1950.

PLASTIC AND RECONSTRUCTIVE SURGERY; A MANUAL OF MANAGEMENT. By Ferris Smith, M.D., F.A.C.S. Philadelphia & London: W. B. Saunders Co., 1950.

PROCEEDINGS OF THE FORTY-THIRD ANNUAL MEETING OF LIFE INSURANCE ASSOCIATION OF AMERICA. Held in The Waldorf-Astoria, New York, N. Y., May 11 and December 15, 1949.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

FREDERICK A. COLLER, Ann Arbor, *President*
HENRY W. CAVE, New York, *President-Elect*

PRELIMINARY PROGRAM FOR THE 36th CLINICAL CONGRESS—HOTEL STATLER, BOSTON OCTOBER 23 TO 27, 1950

COLOR television, clinics, postgraduate courses, forums, symposia, panel discussions, official meetings, films, hospital conferences and exhibits will vie for the attention of the several thousand surgeons and hospital representatives who will attend the thirty-sixth Clinical Congress of the American College of Surgeons in Boston, October 23 to 27. The program in brief which appears on a following page of this issue, and the outlines of many of the programs which follow it, give an idea of the scope and variety of events which have been planned with the help of the Boston Committee on Arrangements headed by Dr. Thomas H. Lanman.

Particular note should be made of the consideration which has been given the surgical specialties, as well as general surgery, in planning this Clinical Congress. There will be special afternoon and evening sessions for ophthalmologists and for otolaryngologists, with a joint session on Wednesday evening. On Friday afternoon, each of six other main surgical specialties will have its own panel discussions. In addition, topics of interest to specialists are interspersed throughout the programs in general surgery. The surgical specialties are also well represented in the clinics, postgraduate courses, forum, television, and medical motion picture programs.

The national emergency will affect the character of the discussions at many of the sessions, and every effort is being made to have the Clinical Congress contribute its share to promoting the medical aspects of civilian defense and of care of the military forces.

POSTGRADUATE COURSES

An exceptionally interesting and new feature of the Clinical Congress in Boston will be the series of five postgraduate courses which will be held from 9:00 a.m. to noon each day at Boston City, Peter Bent Brigham, Children's, Massachusetts General, and Massachusetts Memorial Hospitals. Tickets for these courses will be available at the clinic ticket desk in Mechanics Hall beginning Sunday afternoon. An outline of the schedule follows. For more detail see the September issue of the BULLETIN of the American College of Surgeons and the final *Official Program.*

Nutrition of the Surgical Patient

Monday—Boston City Hospital—Moderator, C. C. LUND, assisted by S. H. INGBAR, C. S. DAVIDSON, G. J. GABUZDA, J. H. CRANDON, W. C. MALONEY, J. M. FOLEY

Tuesday—Massachusetts General Hospital—Moderator, O. COPE, assisted by P. COLVER, W. WADDELL, F. ALBRIGHT, F. BARTER, A. FORBES, N. TALBOT, J. W. RAKER, A. WIGHT, J. T. CRAWFORD, G. NARDI, W. MACDERMOTT

Wednesday — Massachusetts Memorial Hospitals — A. RELMAN, C. P. EMERSON, J. R. STANTON, F. INGELFINGER

Thursday—Children's Hospital—W. WALLACE, J. METCOFF, C. A. JANEWAY

Friday—Peter Bent Brigham Hospital—Moderator, F. D. MOORE, assisted by J. M. OLNEY, I. S. EDELMAN, E. NEPTUNE, R. CARDOSO, C. A. MACGREGOR, D. M. HUME

Vascular Diseases

Monday—Peter Bent Brigham Hospital—Moderator, J. HOMANS, assisted by E. A. EDWARDS, W. LEVER, C. CRANE

Tuesday—Boston City Hospital—Moderator, E. E. O'NEIL, assisted by S. ARMSTRONG, W. WILSON, J. BYRNE, P. FOISIE, G. MILLER

Wednesday—Massachusetts General Hospital—Moderator, A. W. ALLEN, assisted by J. CRANLEY, D. A. FELDER, E. HAMLIN, J. B. MCKITTRICK, R. WARREN, H. FAXON, G. A. DONALSON, C. E. WELCH, I. B. HARDY, R. R. LINTON

Thursday—Massachusetts Memorial Hospitals—R. H. SMITHWICK and Associates

Friday—Children's Hospital—L. MONGINO, O. SWENSON, R. E. GROSS

Fractures of the Spine and Skull

Monday—Children's Hospital—W. T. GREEN, F. D. INGRAHAM, D. D. MATSON

Tuesday—Peter Bent Brigham Hospital—F. D. INGRAHAM, D. D. MATSON and Associates

Wednesday—Boston City Hospital—Moderator, D. MUNRO, assisted by A. P. HEUSNER, W. R. WEGNER, R. D. ADAMS

Thursday—Massachusetts General Hospital—W. H. SWEET, W. A. ROGERS, P. NORTON, J. C. WHITE

Fractures of the Long Bones

Monday—Massachusetts Memorial Hospitals—L. G. HOWARD, K. CHRISTOPHE, R. S. HORMELL, T. A. POTTER, R. H. SMITHWICK

Tuesday—Children's Hospital—W. T. GREEN and Associates

Wednesday—Peter Bent Brigham Hospital—Moderator, T. B. QUIGLEY, assisted by C. WALTON, A. FERGUSON

Thursday—Boston City Hospital—Moderator, J. H. SHORTELL, assisted by O. J. HERMANN, H. K. MAGILL, J. KELLEHER, R. D. ADAMS, R. F. SULLIVAN, R. ULIN, A. P. AITKEN, R. INGERSOL

Friday—Massachusetts General Hospital—C. R. ROWE, O. E. AUFRANC, E. F. CAVE

Preoperative and Postoperative Care

Monday—Massachusetts General Hospital—Moderator, L. S. MCKITTRICK

Tuesday—Massachusetts Memorial Hospitals—C. S. KEEFER, C. W. HOWE, F. INGELFINGER, R. H. SMITHWICK

Wednesday—Children's Hospital—T. H. LANMAN, O. SWENSON, W. WALLACE

Thursday—Peter Bent Brigham Hospital—Moderator, J. E. DUNPHY, assisted by W. DERRICK, C. CRANE, J. BROOKS, D. M. HUME

Friday—Boston City Hospital—Moderator, A. J. A. CAMPBELL, assisted by M. FINLAND, W. R. MORRISSON, S. MIKAL, J. M. MCGOWAN, A. L. DAVIS, C. A. LAMB, W. C. MALONEY

COLOR TELEVISION

Telecasts in color of operations taking place at the Massachusetts General Hospital will be shown in a room in the Mechanics Building every afternoon, Monday through Thursday, and every morning except Monday. Dr. Horatio Rogers of the hospital staff will be in charge of the television.

This demonstration is made possible by Smith, Kline & French Laboratories of Philadelphia. It was at their request that Columbia Broadcasting System, Inc., undertook to specially design and manufacture color television equipment for teaching surgery and medicine. This equipment, the first of its kind to date, is owned by the Laboratories and is being demonstrated by them throughout the country as a contribution to medical teaching. This will be the second demonstration at a Clinical Congress, the first having been in Chicago in October, 1949. Previously, at the Congresses in Los Angeles in 1948 and in New York in 1947, the television was in black and white. The Los Angeles showing was sponsored by the *Los Angeles Times* and the New York showing, which was the first use of television at a national medical meeting, was made possible by a grant from the Johnson & Johnson Research Foundation.

PRESIDENTIAL MEETING AND CONVOCATION

Dr. Frederick A. Coller of Ann Arbor will deliver the Presidential Address at the Presidential Meeting on Monday evening. His subject will be "For the Benefit of the Patients." At the same session Dr. Henry W. Cave of New York will be installed as President, and Dr. Warren H. Cole of Chicago and Dr. G. Gavin Miller of Montreal as First and Second Vice Presidents respectively. The fifth Martin Memorial Lecture will be delivered by Professor Sir Geoffrey Jefferson, C.B.E., F.R.C.S. (Eng.), Manchester, England. His subject will be "The Balance of Life and Death in Intracranial Lesions."

The annual Convocation which includes formal initiation ceremonies for the new Fellows will take place on Friday evening, October 27, in Symphony Hall. The Fellowship Address will be given by Dr. Paul R. Hawley, The Director of the College. His subject will be "Quo Vadimus?"

HOSPITAL CLINICS

Under the leadership of the Committee on Arrangements, and the representatives of the participating hospitals, a program of operative and nonoperative clinics is being arranged in 25 hospitals as a major feature of the Clinical Congress. The schedules of clinics, which will cover general surgery, obstetrics and gynecology, fractures and other trauma, neurosurgery, orthopedic, thoracic, and genitourinary surgery, and ophthalmology and otorhinolaryngology, will be published in a *Daily Clinical Bulletin* which will be issued each day during the Clinical Congress. The clinic schedules will also be posted on bulletin boards.

The hospitals which will arrange clinics, and the names of the hospital representatives, follow:

Beth Israel Hospital—DR. HOWARD A. FRANK

Boston City Hospital—DR. J. EDWARD FLYNN

Boston Lying-In Hospital—DR. PAUL GUSTAFSON

Carney Hospital—DR. JOHN J. TODD

Chelsea Naval Hospital—DR. HENRY W. HUDSON

Children's Medical Center—DR. WILLIAM A. ELLISTON

Cushing Veterans Administration Hospital—DR. HENRY FAXON

Faulkner Hospital—DR. MARSHALL K. BARTLETT

Free Hospital for Women—DR. CHRISTOPHER J. DUNCAN

Malden Hospital—DR. CLEMENT LYNCH

Massachusetts Eye and Ear Infirmary—Ophthalmology—DR. HENRY A. MOSHER

Massachusetts Eye and Ear Infirmary—Otorhinolaryngology—DR. FRANCIS L. WEILLE

Massachusetts General Hospital—DR. HOWARD ULFELDER; Television chairman—DR. HORATIO ROGERS

Massachusetts Memorial Hospitals—Dr. George Whitelaw
New England Baptist Hospital—Dr. Herbert D. Adams
New England Center Hospital—Dr. Wyland Leadbetter
New England Deaconess Hospital—Dr. Herbert D. Adams
New England Deaconess Hospital—Palmer Memorial Unit—Dr. Clifford Franseen
New England Hospital for Women and Children—Dr. Felicia Banas
Newton-Wellesley Hospital, Newton Lower Falls—Dr. Richard I. Smith
Peter Bent Brigham Hospital—Dr. Thomas B. Quigley
Pondville Hospital, Walpole—Dr. Richard Wallace
Robert Breck Brigham Hospital—Dr. Theodore A. Potter
St. Elizabeth's Hospital—Dr. John Spellman
Veterans Administration Hospital—West Roxbury—Dr. Frederick Ross

EVENING SCIENTIFIC SESSIONS

Eminent surgeons and specialists, recognized as authorities in their fields, will address the scientific meetings on Tuesday, Wednesday, and Thursday evenings.

Separate sessions for Ophthalmology and for Otorhinolaryngology will be held on Tuesday and Thursday evenings. The Wednesday evening meeting for these groups will be a joint session.

Preliminary programs for all of the evening scientific sessions appear on succeeding pages.

AFTERNOON PANEL DISCUSSIONS, GENERAL SURGERY AND OPHTHALMOLOGY AND OTORHINOLARYNGOLOGY

General surgery panel discussions will be held Monday through Thursday afternoons from 1:30 to 3:00 o'clock and Monday through Wednesday afternoons from 3:30 to 5:00 o'clock.

Ophthalmology panel discussions will be held Tuesday, Wednesday, and Thursday afternoons from 1:30 to 3:00 o'clock.

Otorhinolaryngology panel discussions will be held Tuesday, Wednesday, and Thursday afternoons from 3:30 to 5:00 o'clock.

Preliminary programs for all of the afternoon panel discussions appear on succeeding pages.

AFTERNOON PANEL DISCUSSIONS, SURGICAL SPECIALTIES

Friday afternoon will be devoted to panel discussion sessions for six special fields of surgery: urology, plastic surgery, neurological surgery, thoracic surgery, gynecology and obstetrics, and orthopedic surgery. Programs appear on succeeding pages.

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

The Forum on Fundamental Surgical Problems at the 1950 Clinical Congress will again give special opportunity for the presentation of the newest discoveries resulting from research, particularly by the younger surgeons. Brief reports of original clinical and experimental observations relating to surgery in its broadest sense, including the surgical specialties, will be given. It is expected this year to have two of the Forum sessions devoted to reports of research on a single surgical specialty. The program is under the general direction of Dr. Owen H. Wangensteen, chairman of the committee. An outline of the programs appears on succeeding pages.

Abstracts of all papers which have been accepted for presentation in the Forum Sessions will be printed in the official program of the Clinical Congress. In the past, the abstracts were printed also in the subsequent issue of the Quarterly Bulletin of the American College of Surgeons. This year, arrangements have been made by the College to begin the publication of an annual bound volume of the Forum papers and the former practice of printing the abstracts in the Bulletin will be discontinued. Early publication of the Forum papers is important and the volume will be published by the W. B. Saunders Company within four months of the time of the Clinical Congress.

SPORTS INJURIES, TRAUMA, CANCER, GRADUATE TRAINING IN SURGERY, AND CLINICOPATHOLOGICAL CONFERENCE

Four symposia on special themes of wide interest are to be held during the Clinical Congress. On Tuesday morning there will be a Symposium on Sports Injuries, on Wednesday afternoon a Symposium on Cancer, and on Thursday morning a Symposium on Trauma. Programs for the two latter appear on succeeding pages.

A Symposium on Graduate Training in Surgery is being planned for Thursday afternoon.

A Clinicopathological Conference will be held on Wednesday morning in Mechanics Hall. Dr. Tracy B. Mallory is Chairman.

MEDICAL MOTION PICTURE PROGRAM

The Medical Motion Picture Committee is now choosing films which are to be shown at the Clinical Congress. Films that have been recently produced should be forwarded to the College for immediate review as it is the policy to include in the Clinical Congress program only those films which were submitted in time to obtain approval by the Committee on Medical Motion Pictures.

HOSPITAL CONFERENCES

The twenty-ninth Hospital Standardization Conference will convene during the Clinical

Congress. Hospital administrators, trustees, members of medical staffs, nurses, technicians, dietitians, and heads of the various hospital departments and their personnel, are invited to participate. An outline of the program appears on succeeding pages.

MEETINGS OF THE BOARD OF GOVERNORS AND FELLOWS

The Board of Governors of the College will convene with luncheon on Monday and will meet from 12:45 to 5:00 p.m. Any unfinished business will be discussed at a session on Wednesday morning. There will be an adjourned meeting at 3:30 p.m. on Thursday. The program appears later in this issue. The Governors will act as a clearing house for the Board of Regents on general assigned subjects and on local problems. They are being apprised of the actions taken by the Board of Regents and will aid in interpreting them to the Fellows.

The Annual Meeting of Fellows will be held on Thursday at 3:45 p.m. The agendum is published on a succeeding page.

COMMITTEE MEETINGS

There will be a meeting of State and Provincial Counseling Committees (formerly State and Provincial Executive Committees), Credential Committees, Committees on Applicants and Judiciary Committees, on Wednesday from 10:00 a.m. until noon at the Copley Plaza Hotel. Dr. Paul R. Hawley, Director of the College, will discuss the role of these committees in elevating the prestige of the College and Dr. H. Prather Saunders, Associate Director, will describe consideration of applicants for the Junior and Senior Candidate Groups and for Fellowship.

COMMITTEE ON ARRANGEMENTS

The Boston Committee on General Arrangements for the Clinical Congress is composed of the following Fellows:

*Thomas H. Lanman, *Chairman*
*Donald Munro, *Vice-Chairman*
*Orvar Swenson, *Secretary*
*Arthur W. Allen, *Chairman*, Board of Regents

Edwin W. Cave	Charles G. Mixter
Edward D. Churchill	Francis D. Moore
Fletcher H. Colby	Gordon M. Morrison
Edwin B. Dunphy	William R. Morrison
*J. Englebert Dunphy	*Langdon Parsons
Henry H. Faxon	Walter G. Phippen
Robert E. Gross	Duncan E. Reid
Frank H. Lahey	LeRoy A. Schall
Charles C. Lund	Reginald H. Smithwick
Leland S. McKittrick	Grantley W. Taylor
Henry C. Marble	*C. Stuart Welch
Joe Vincent Meigs	

*Executive Committee

GENERAL, PROGRAM, AND PUBLIC RELATIONS COMMITTEES

The Clinical Congress General Committee consists of Dr. Paul R. Hawley, Chairman, Eleanor K. Grimm, Secretary, Dr. Walter E. Batchelder, Laura G. Jackson, Dr. George H. Miller, Edward G. Sandrok, Dr. H. Prather Saunders, James S. Shannon, and Dr. George W. Stephenson.

The Clinical Congress Committee on Programs consists of Dr. Frederick A. Coller, Chairman, and Doctors Henry W. Cave, Evarts A. Graham, and Alton Ochsner. Programs for the specialties are being arranged in co-operation with the Advisory Councils of the College on ophthalmology, otorhinolaryngology, neurological surgery, obstetrics and gynecology, orthopedic surgery, thoracic surgery, and urology.

The Advisory Committee on Programs consists of Dr. George H. Miller, Chairman, and Doctors Warren H. Cole, Paul R. Hawley, Sumner L. Koch, Malcolm T. MacEachern, Michael L. Mason, Charles B. Puestow, H. Prather Saunders, and George W. Stephenson.

The Public Relations Committee consists of Dr. Charles B. Puestow, Chairman, members of administrative staff, American College of Surgeons, and members of the local committee on publicity, of which Dr. Charles C. Lund is Chairman.

SCIENTIFIC EXHIBITS

For the first time at a Clinical Congress of the American College of Surgeons, opportunity is being given to outside individuals and institutions to take part in the scientific exhibit, which heretofore has been practically limited to College activities. This being a new venture, it is considered a pilot project, and its popularity in Boston will determine whether the plan will be continued in the future. Several of the outstanding scientists in the Boston area have been approached and have expressed willingness to participate. Preliminary negotiations indicate that the exhibits will be most instructive and interesting. The final official program of the Clinical Congress will include lists and brief descriptions of the exhibits, with booth numbers.

TECHNICAL EXHIBITS

Mechanics Hall will house the extensive exhibit of medical and hospital supplies and equipment, television and medical motion picture showings, registration for surgeons and hospital representatives, and a few of the sessions. Leading manufacturers of surgical equipment and instruments, sutures, dressings, pharmaceuticals, and surgical supplies of all kinds, and publishers of medical

books will be represented in the exhibition. A list of the exhibitors appears on a following page.

POST CLINICAL CONGRESS COURSE

A course on Treatment of Fractures and Other Conditions will be held from October 30 to November 4, the week following the Clinical Congress, under the direction of Dr. Edwin F. Cave and associates of Massachusetts General Hospital. This course will deal primarily with the treatment of fractures, but the management of many other traumatic conditions will be presented. Attendance is limited to 100 students. Apply to the Assistant Dean, Courses for Graduates, Harvard Medical School, Boston.

ADVANCE REGISTRATION

Surgeons who wish to attend the Clinical Congress should register in advance. Advance registration will greatly expedite the procedure of registering. No registration fee will be charged Fellows whose dues are paid to December 31, 1949. For endorsed Junior and Senior Candidates, the fee will be $5.00. Non-Fellows who after individual consideration are permitted to register, will pay a fee of $10.00. No registration fee will be required of initiates of the class of 1950.

POST CONGRESS CRUISE TO BERMUDA

A cruise to Bermuda following the Clinical Congress may be arranged through Leon V. Arnold, 36 Washington Square West, New York 11. Fellows from the West may have their rail tickets routed via New York for their return at no additional expense. A late evening train from Boston on Friday, October 27, gives Saturday morning arrival in New York in ample time for some shopping in that city prior to embarking on the luxury liner, "Queen of Bermuda," which will sail at 3:00 p.m. Arrival in Bermuda will be at 9:00 a.m. on Monday, and the cruise members will be accommodated at the Hotel Princess in Hamilton. About two and a half days are allowed for sightseeing in Bermuda, with the return sailing on Wednesday, November 1, at 3:00 p.m., and arrival in New York on Friday at 9:00 a.m. The minimum cost per person including boat and hotel accommodations and most meals, is around $200. Reservations should be made as early as possible.

ENTERTAINMENT FOR GUESTS

With Mrs. Arthur W. Allen as Honorary Chairman and Mrs. Thomas H. Lanman as Chairman, a committee has been organized in Boston to plan entertainment for guests of the Fellows attending the Clinical Congress. The members of the committee are Mesdames A. J. A. Campbell, Edwin F. Cave, Robert E. Gross, Leland S. McKittrick, Joe V. Meigs, Charles G. Mixter, Francis D. Moore, Donald Munro, John W. Spellman, and C. Stuart Welch. Among the events planned are a tour of the city, an evening at a Gilbert & Sullivan opera performance, and a tea and fashion show.

HOTEL RESERVATIONS

It is desirable to make hotel reservations as early as possible. In making these, communications should be addressed to the Convention Bureau of the Boston Chamber of Commerce, 80 Federal Street, Boston 10. It is important that you state that you will be attending the Clinical Congress of the American College of Surgeons. All hotel reservations, both for surgeons and hospital representatives, are to clear through the Convention Bureau. No correspondence should be sent directly to the hotels. A form for reservations was enclosed in a letter to Fellows. Choice of hotels may be designated.

In addition to the headquarters hotels, the Statler and Copley Plaza, there are a number of first-class hotels within a short distance of headquarters. The following hotels are recommended:

	Minimum Rate with Bath	
	Single	Double
Bellevue	$4.00	$ 6.00
Bradford	5.00	7.00
Copley Plaza	5.00	7.70
Kenmore	5.00	9.00
Manger	4.00	5.50
New Ocean House, Swampscott	6.00	8.00
Parker House	4.50	7.00
Somerset	6.00	10.00
Statler	5.00	8.75
Touraine	4.50	7.00

PROGRAM IN BRIEF

Monday, October 23

8:00–12:00 Clinics and Demonstrations at local hospitals
9:00–12:00 Postgraduate Courses at Boston City, Peter Bent Brigham, Children's, Massachusetts General and Massachusetts Memorial Hospitals
10:00–12:00 General Assembly
12:45– 2:00 Governors' Luncheon
1:30– 3:00 Panel Discussion
1:30– 5:00 Medical Motion Pictures
1:30– 4:30 Television
1:30– 5:00 Clinics and Demonstrations at local hospitals
2:00– 5:00 Annual Meeting of Governors
2:00– 5:00 Forum on Fundamental Surgical Problems
2:00– 5:00 Hospital Conference
3:30– 5:00 Panel Discussion
8:30–10:00 Presidential Meeting

Tuesday, October 24

8:00–12:00 Clinics and Demonstrations at local hospitals
8:30–12:00 Television
9:00–12:00 Postgraduate Courses at Boston City, Peter Bent Brigham, Children's, Massachusetts General and Massachusetts Memorial Hospitals
9:00–12:00 Forum on Fundamental Surgical Problems (2 sections)
9:30–12:30 Medical Motion Pictures
9:30–12:30 Hospital Conference
10:00–12:00 Symposium on Sports Injuries
1:30– 3:00 Panel Discussion
1:30– 4:30 Television
1:30– 3:00 Panel, Ophthalmology
1:30– 5:00 Clinics and Demonstrations at local hospitals
1:30– 5:00 Medical Motion Pictures
2:00– 5:00 Forum on Fundamental Surgical Problems
2:00– 5:00 Hospital Conference
3:30– 5:00 Panel Discussion
3:30– 5:00 Panel, Otorhinolaryngology
7:00– 8:00 Medical Motion Pictures (EENT)
7:45–10:00 Hospital Conference
8:30–10:30 Scientific Session, General Surgery
8:30–10:30 Scientific Session, Otorhinolaryngology
8:30–10:30 Scientific Session, Ophthalmology

Wednesday, October 25

7:45– 9:30 Hospital Breakfast Conference
8:00–12:00 Clinics and Demonstrations at local hospitals
8:00–10:00 Governors' Meeting (Unfinished Business)
8:30–12:00 Television
9:00–12:00 Postgraduate Courses at Boston City, Peter Bent Brigham, Children's, Massachusetts General and Massachusetts Memorial Hospitals
9:00–12:00 Forum on Fundamental Surgical Problems (2 sections)
9:30–12:30 Medical Motion Pictures
10:00–12:00 Credentials, Judiciary, and Counseling Committees
10:00–12:30 Hospital Conference
10:30–12:00 Clinicopathological Conference
1:30– 3:00 Panel Discussion
1:30– 3:00 Panel, Ophthalmology
1:30– 4:30 Television
1:30– 5:00 Clinics and Demonstrations at local hospitals
1:30– 5:00 Medical Motion Pictures
2:00– 5:00 Forum on Fundamental Surgical Problems
2:00– 5:00 Hospital Conference
2:00– 5:00 Hospital Demonstration
2:00– 5:00 Cancer Symposium
3:30– 5:00 Panel Discussion
3:30– 5:00 Panel, Otorhinolaryngology
3:30– 5:00 Meeting of Regional and National Trauma Committees
7:00– 8:00 Medical Motion Pictures (EENT)
7:45–10:00 Hospital Conference
8:30–10:30 Scientific Session, General Surgery
8:30–10:30 Scientific Session, Ophthalmology and Otorhinolaryngology (Joint Session with New England Otolaryngological Society)

Thursday, October 26

7:45– 9:15 Hospital Conference Breakfast
8:00–12:00 Clinics and Demonstrations at local hospitals
8:30–12:00 Television
9:00–12:00 Postgraduate Courses at Boston City, Peter Bent Brigham, Children's, Massachusetts General and Massachusetts Memorial Hospitals
9:00–12:00 Forum on Fundamental Surgical Problems (3 sections)
9:00–12:00 Symposium on Trauma
9:30–12:30 Medical Motion Pictures
9:30–12:30 Hospital Conference
10:00–12:00 Medical Motion Pictures Committees
1:15– 3:20 Forum on Anesthesia
1:30– 3:00 Panel Discussion
1:30– 3:30 Medical Motion Pictures
1:30– 4:30 Television
1:30– 3:00 Panel, Ophthalmology
1:30– 3:00 Panel, Otorhinolaryngology
1:30– 3:00 Clinics and Demonstrations at local hospitals
1:30– 3:00 Symposium, Graduate Training in Surgery
2:00– 5:00 Hospital Conference
2:00– 5:00 Hospital Demonstration
3:30– 3:45 Adjourned Meeting, Governors
3:45– 6:00 Annual Meeting of Fellows
7:00– 8:00 Medical Motion Pictures (EENT)
7:45–10:00 Hospital Conference
8:30–10:30 Scientific Session, General Surgery
8:30–10:30 Scientific Session, Ophthalmology
8:30–10:30 Scientific Session, Otorhinolaryngology

Friday, October 27

8:00–12:00 Clinics and Demonstrations at local hospitals
8:30–12:00 Television
9:00–12:00 Postgraduate Courses at Boston City, Peter Bent Brigham, Children's, Massachusetts General and Massachusetts Memorial Hospitals
9:00–12:00 Forum on Fundamental Surgical Problems (2 sections)
9:30–12:30 Medical Motion Pictures
10:00– 4:00 Hospital Demonstrations
10:30–12:00 Assembly of Initiates
1:30– 4:45 Panel Discussion for each of the following:
Gynecology and Obstetrics
Plastic Surgery
Neurological Surgery
Thoracic Surgery
Urology
Orthopedic Surgery
1:30– 5:00 Clinics and Demonstrations at local hospitals
8:30–10:00 Convocation

PRELIMINARY PROGRAM

GENERAL ASSEMBLY

Monday, 10:00 a.m.—12:00 m.—Grand Hall, Mechanics Building

FREDERICK A. COLLER, M.D., F.A.C.S., Ann Arbor; President, American College of Surgeons, *Presiding.*
Official Greetings
Co-ordinated Program, Graduate Training in Surgery. FREDERICK A. COLLER, M.D., F.A.C.S., Chairman, Committee on Graduate Training in Surgery.
Medical Services in the Department of Defense. RICHARD L. MEILING, M.D., F.A.C.S., Washington, D.C.; Director, Office of Medical Services, United States Department of Defense.
Where Do We Go from Here in Veterans' Medicine? PAUL B. MAGNUSON, M.D., F.A.C.S., Washington, D.C.; Chief Medical Officer, United States Veterans Administration
First and Foremost. THE HONORABLE ARTHUR B. LANGLIE, Olympia, Washington; Governor of the State of Washington.

PRESIDENTIAL MEETING

Monday, 8:30—10:00 p.m.—Ballroom, Hotel Statler

FREDERICK A. COLLER, M.D., F.A.C.S., Ann Arbor; President, American College of Surgeons, *Presiding.*
Processional—Officers, Regents and Distinguished Guests
Invocation
Address of Welcome. THOMAS H. LANMAN, M.D., F.A.C.S., Boston; Chairman, Committee on Arrangements
Introduction of Distinguished Guests. ARTHUR W. ALLEN, M.D., F.A.C.S., Boston; Chairman, Board of Regents.
Address of the President: For the Benefit of the Patients. FREDERICK A. COLLER, M.D.
Inauguration of Officers:
Presented by DONALD G. TOLLEFSON, M.D., F.A.C.S., Los Angeles; Retiring First Vice-President.
First Vice-President: WARREN H. COLE, M.D., F.A.C.S., Chicago.
Second Vice-President: G. GAVIN MILLER, M.D., F.A.C.S., Montreal.
President: HENRY W. CAVE, M.D., F.A.C.S., New York.
The Fifth Martin Memorial Lecture: The Balance of Life and Death in Intracranial Lesions. Professor SIR GEOFFREY JEFFERSON, C.B.E., F.R.C.S. (Eng.), Manchester, England; Professor of Neurosurgery, University of Manchester Medical School.
Recessional

CONVOCATION

Friday, 8:30—10:00 p.m.—Symphony Hall

HENRY W. CAVE, M.D., F.A.C.S., New York; President, American College of Surgeons, *Presiding.*
Processional—Initiates, Governors, Officers, Regents, and Distinguished Guests.
Invocation
Presentation of Initiates for Fellowship. ARTHUR W. ALLEN, M.D., F.A.C.S., Boston; Chairman, Board of Regents.
Fellowship Pledge. The Initiates.
Conferring of Fellowships by the President. HENRY W. CAVE, M.D.
Conferring of Honorary Fellowships. The President.
Fellowship Address: "Quo Vadimus?" PAUL R. HAWLEY, M.D., Chicago; The Director, American College of Surgeons.
Recessional

EVENING SCIENTIFIC SESSIONS

GENERAL SURGERY

Tuesday, 8:30—10:30 p.m.—Ballroom, Hotel Statler

HENRY W. CAVE, M.D., F.A.C.S., New York, *Presiding.*
The Concept of the General-Adaptation-Syndrome as Applied to Surgical Problems (with Special Emphasis upon Cortisone and ACTH). HANS SELYE, M.D., Montreal.
Biophysics in Surgery. AMBROSE STORCK, M.D., F.A.C.S., New Orleans.
The Principles Involved in the Clinical Use of Streptokinase-Streptodornase. WILLIAM S. TILLETT, M.D., New York.

Wednesday, 8:30—10:30 p.m.—Ballroom, Hotel Statler

WARREN H. COLE, M.D., F.A.C.S., Chicago, *Presiding.*
Fracture Oration. Thoughts on Fractures and Other Traumata. J. HUBER WAGNER, M.D., F.A.C.S., Pittsburgh.
Intravenous Fat Feeding. FREDRICK J. STARE, M.D., Boston.
The Neurological Complications of Spinal Anesthesia. ROBERT D. DRIPPS, M.D., Philadelphia.

Thursday 8:30—10:30 p.m.—Ballroom, Copley Plaza Hotel

G. GAVIN MILLER, M.D., F.A.C.S., Montreal, *Presiding.*
Late Surgical Complications Following Irradiation of Pelvic Viscera. WILLIAM CRAWFORD WHITE, M.D., F.A.C.S., New York.
A New Surgical Treatment for Hirschsprung's Disease. ORVAR SWENSON, M.D., F.A.C.S., Boston.
Lobotomy vs. Cordotomy for the Relief of Intractable Pain. JAMES C. WHITE, M.D., F.A.C.S., Boston.

EVENING SESSIONS FOR OPHTHALMOLOGY

Tuesday, 8:30—10:30 p.m.—State Salon, Copley Plaza Hotel

BENJAMIN SACHS, M.D., Boston, *Presiding.*
Treatment of Pigmented Tumors of the Eye and Adnexa. JOHN S. MCGAVIC, M.D., Bryn Mawr, Pennsylvania.
The Use of ACTH and Cortisone in Ophthalmology. DAN M. GORDON, M.D., New York.
Scleral Resection. RAYMOND E. MEEK, M.D., F.A.C.S., New York.

Thursday, 8:30—10:30 p.m.—State Salon, Copley Plaza Hotel

EDWIN B. DUNPHY, M.D., F.A.C.S., Boston, *Presiding.*
Glaucoma After Cataract Extraction. PAUL A. CHANDLER, M.D., Boston.
Present Trend in Surgery of the Oblique Muscles. WALTER H. FINK, M.D., F.A.C.S., Minneapolis.
End Results of Integrated Implants in the Orbit. WILLIAM STONE, Jr., M.D., Boston.

EVENING SESSIONS FOR OTOLARYNGOLOGY

Tuesday, 8:30—10:30 p.m.—Sheraton Room, Copley Plaza Hotel

LEROY A. SCHALL, M.D., F.A.C.S., Boston, *Presiding.*
The Present Status of the Relationship of Tonsillectomy to Poliomyelitis. DANIEL S. CUNNING, M.D., F.A.C.S., New York.
Modern Bacteriology as an Aid to the Otolaryngologist. ANITA MANGIARACINE, Boston.
The Influence of Fundamental Concepts in Allergy upon Specific Problems in Otolaryngology. FRANCIS L. WEILLE, M.D., F.A.C.S., Boston.

Thursday, 8:30—10:30 p.m.—Sheraton Room, Copley Plaza Hotel

CARL H. MCCASKEY, M.D., F.A.C.S., Indianapolis, *Presiding.*
Symposium on "Tumors of the Nose and Sinuses."
Symptomatology. LEROY A. SCHALL, M.D., F.A.C.S., Boston.
X-Ray Diagnosis. ALEXANDER S. MACMILLAN, M.D., Boston.
Preparation and Care of the Mouth of the Patient Receiving X-Ray Therapy About the Head and Neck. MILFORD D. SCHULZ, M.D., Boston.
Treatment By A Combination of Surgery and Radiation. HAYES E. MARTIN, M.D., F.A.C.S., New York.

OPHTHALMOLOGY AND OTOLARYNGOLOGY—

JOINT SESSION WITH THE NEW ENGLAND OTOLARYNGOLOGICAL SOCIETY

Wednesday, 8:30—10:30 p.m.—Sheraton Room, Copley Plaza Hotel

ROBERT L. GOODALE, M.D., Boston, President, New England Otolaryngological Society, and MILTON F. LITTLE, M.D., Hartford, President, New England Ophthalmological Society, *Presiding.*
Antibiotics Today. CHESTER S. KEEFER, M.D., Boston.
Ophthalmological Applications of the Newer Antibiotics. IRVING H. LEOPOLD, M.D., Philadelphia.
Use of Antibiotics in Otolaryngology. FRANCIS W. DAVISON, M.D., Danville, Pennsylvania.

PANEL DISCUSSIONS

GENERAL SURGERY

Monday, 1:30—3:00 p.m.—Grand Hall, Mechanics Building

Transthoracic Approach to Subdiaphragmatic Lesions
Moderator: B. NOLAND CARTER, M.D., F.A.C.S., Cincinnati.
Collaborators: RICHARD H. SWEET, M.D., F.A.C.S., Boston; HENRY K. BEECHER, M.D., Boston; R. ARNOLD Griswold, M.D., F.A.C.S., Louisville.

Monday, 3:30—5:00 p.m.—Grand Hall, Mechanics Building

Cancer of the Uterus
Moderator: JOHN C. BURCH, M.D., F.A.C.S., Nashville.
Collaborators: JOE V. MEIGS, M.D., F.A.C.S., Boston; AXEL N. ARNESON, M.D., St. Louis; F. BAYARD Carter, M.D., Durham, North Carolina.

Tuesday, 1:30—3:00 p.m.—Grand Hall, Mechanics Building

Complemental Combinations in Anesthesia
Moderator: WESLEY BOURNE, M.D., Montreal.
Collaborators: RALPH T. KNIGHT, M.D., F.A.C.S., Minneapolis. ROLLAND J. WHITACRE, M.D., Cleveland. JOHN ADRIANI, M.D., New Orleans.

Tuesday, 3:30—5:00 p.m.—Grand Hall, Mechanics Building

Reconstructive Surgery of the Hand
Moderator: HENRY C. MARBLE, M.D., F.A.C.S., Boston.
Collaborators: J. HAROLD COUCH, M.D., Toronto; SUMNER L. KOCH, M.D., F.A.C.S., Chicago; J. WILLIAM LITTLER, M.D., New York; SIR ARCHIBALD MCINDOE, C.B.E., F.A.C.S., F.R.C.S. (Eng.), London.

Wednesday, 1:30—3:00 p.m.—Grand Hall, Mechanics Building

Surgical Treatment of Congenital Anomalies of the Digestive Tract
Moderator: LAWRENCE CHAFFIN, M.D., F.A.C.S., Los Angeles.
Collaborators: CAMERON HAIGHT, M.D., F.A.C.S., Ann Arbor; WILLIAM P. LONGMIRE, Jr., M.D., F.A.C.S., Los Angeles; HERBERT E. COE, M.D., F.A.C.S., Seattle.

Wednesday, 3:30—5:00 p.m.—Grand Hall, Mechanics Building

Pitfalls in Surgery of the Gall Bladder and Biliary Ducts
Moderator: WALTMAN WALTERS, M.D., F.A.C.S., Rochester, Minnesota.
Collaborators: WARREN H. COLE, M.D., F.A.C.S., Chicago; M. JOSEPH HENRY, M.D., F.A.C.S., Louisville; RODNEY H. MAINGOT, F.R.C.S. (Eng.), London; G. GAVIN MILLER, M.D., F.A.C.S., Montreal.

Thursday, 1:30—3:00 p.m.—Grand Hall, Mechanics Building

Acute, Nontraumatic Conditions in the Abdomen
Moderator: FRED W. RANKIN, M.D., F.A.C.S., Lexington.
Collaborators: HAROLD L. FOSS, M.D., F.A.C.S., Danville, Pennsylvania; HORACE J. MCCORKLE, M.D. F.A.C.S., San Francisco; I. MIMS GAGE, M.D., F.A.C.S., New Orleans.

OPHTHALMOLOGY

Tuesday, 1:30—3:00 p.m.—Sheraton Room, Copley Plaza Hotel

Moderator: WILLIAM JASON MIXTER, M.D., F.A.C.S., Boston.
Chiasmal Syndrome
Collaborators: RAYMOND D. ADAMS, M.D., Boston; GILBERT HORRAX, M.D., Sc.D. (Hon.), F.A.C.S., Poston; DAVID G. COGAN, M.D., Boston.

Wednesday, 1:30—3:00 p.m.—Sheraton Room, Copley Plaza Hotel

Moderator: WILLIAM L. BENEDICT, M.D., F.A.C.S., Rochester, Minnesota.
Diagnosis of Orbital Tumors
COLLABORATORS: VIRGIL G. CASTEN, M.D., F.A.C.S., Boston; CHARLES A. PERERA, M.D., Sc. D., New York; JACK S. GUYTON, M.D., Baltimore.

Thursday, 1:30—3:00 p.m.—Ballroom Foyer, Copley Plaza Hotel

Moderator: EDMUND B. SPAETH, M.D., F.A.C.S., Philadelphia.
Selection of Operative Technique in Retinal Separation
Collaborators: HARVEY E. THORPE, M.D., F.A.C.S., Pittsburgh; R. TOWNLEY PATON, M.D., F.A.C.S., New York; GIROLAMO BONACCOLOTO, M.D., F.A.C.S., New York.

OTOLARYNGOLOGY

Tuesday, 3:30—5:00 p.m.—Sheraton Room, Copley Plaza Hotel

Moderator: PHILIP E. MELTZER, M.D., Boston.
The Pre-school Deaf Child
Collaborators: DONALD K. LEWIS, M.D., Boston; MISS HELEN T. PATTEN, Boston; EDMUND P. FOWLER, Jr., M.D., New York; CLARENCE D. O'CONNOR, L.H.D., New York.

Joint Meeting with New England Otolaryngological Society

Wednesday, 3:30—5:00 p.m.—Sheraton Room, Copley Plaza Hotel

Moderator: MARVIN FISHER JONES, M.D., F.A.C.S., New York.
What We Have Learned about Fenestration for Otosclerosis
Collaborators: GEORGE E. SHAMBAUGH, Jr., M.D., Chicago; J. BROWN FARRIOR, M.D., F.A.C.S., Tampa; JULIUS LEMPERT, M.D., New York; HOWARD P. HOUSE, M.D., F.A.C.S., Los Angeles.

Thursday, 1:30—3:00 p.m.—Sheraton Room, Copley Plaza Hotel

Moderator: LEIGHTON F. JOHNSON, M.D., F.A.C.S., Boston.
The Management of the Vertigenous Patient
Collaborators: BENJAMIN SPECTOR, M.D., Boston; JAMES L. POPPEN, M.D., F.A.C.S., Boston; CHARLES S. KUBIK, M.D., Boston; FRANK D. LATHROP, M.D., F.A.C.S., and WILLIAM MALAMUD, M.D., Boston.

SURGICAL SPECIALTIES, FRIDAY, 1:30–4:45 P.M.

Orthopedic Surgery

Moderator: G. EDMUND HAGGART, M.D., F.A.C.S., Boston.
The Management of Fractures and Dislocations of the Dorsal and Lumbar Spine
Collaborators: HARRISON L. MCLAUGHLIN, M.D., F.A.C.S., New York; J. HUBER WAGNER, M.D., F.A.C.S., Pittsburgh; SAM W. BANKS, M.D., F.A.C.S., Chicago.
Fractures of the Elbow Region in Children
COLLABORATORS: WILLIAM H. BICKEL, M.D., F.A.C.S., Rochester, Minnesota; MAURICE M. PIKE, M.D. F.A.C.S., Hartford; HAROLD A. SOFIELD, M.D., F.A.C.S., Oak Park, Illinois.

Urology

Moderator: THOMAS D. MOORE, M.D., F.A.C.S., Memphis.
Injuries of the Ureter
Collaborators: THOMAS J. KIRWIN, M.D., F.A.C.S., New York; PARKE G. SMITH, M.D., F.A.C.S., Cincinnati; CLYDE L. DEMING, M.D., F.A.C.S., New Haven.
Congenital Anomalies of the Lower Urinary Tract
Collaborators: BRADLEY M. PATTEN, Ph.D., Ann Arbor; MEREDITH F. CAMPBELL, M.D., New York; EDGAR BURNS, M.D., F.A.C.S., New Orleans.

Plastic Surgery

Moderator: JAMES BARRETT BROWN, M.D., F.A.C.S., St. Louis.
Plastic Surgical Repair of Radiation Lesions
Collaborators: MICHAEL L. MASON, M.D., F.A.C.S., Chicago; FRANK MCDOWELL, M.D., F.A.C.S., St. Louis; FREDERICK A. FIGI, M.D., F.A.C.S., Rochester, Minnesota.
Military Plastic Surgery
Collaborators: BRADFORD CANNON, M.D., F.A.C.S., Boston; CLIFFORD L. KIEHN, M.D., Cleveland; DOUGLAS W. MACOMBER, M.D., F.A.C.S., Denver.

Gynecology and Obstetrics

Moderator: FREDERICK H. FALLS, M.D., F.A.C.S., Chicago.
Indications for Abdominal Total Hysterectomy versus Vaginal Total Hysterectomy for Non-Malignant Uterine Pathology
Collaborators: KARL H. MARTZLOFF, M.D., F.A.C.S., Portland, Oregon; ARCHIBALD D. CAMPBELL, M.D., C.M., F.R.C.S.(C.), F.R.C.O.G., F.A.C.S., Montreal; RALPH E. CAMPBELL, M.D., F.A.C.S., Madison.
The Management of Urinary Incontinence in Women
Collaborators: NORMAN F. MILLER, M.D., F.A.C.S., Ann Arbor; ANDREW A. MARCHETTI, M.D., F.A.C.S., Washington, D.C.; LOUIS E. PHANEUF, M.D., F.A.C.S., Boston

Thoracic Surgery

Moderator: HERBERT C. MAIER, M.D., F.A.C.S., New York.
Postoperative Pulmonary Complications
Collaborators: CARL A. MOYER, M.D., F.A.C.S., Dallas; GORDON A. DONALDSON, M.D., F.A.C.S., Boston; ROLLIN A. DANIEL, Jr., M.D., F.A.C.S., Nashville.
Moderator: FRANK B. BERRY, M.D., F.A.C.S., New York.
Trauma of the Chest and Upper Abdomen
Collaborators: ROBERT H. WYLIE, M.D., F.A.C.S., New York; WILLIAM M. TUTTLE, M.D., Detroit; HOWARD SNYDER, M.D., F.A.C.S., Winfield, Kansas.

Neurological Surgery

Moderator: BRONSON S. RAY, M.D., New York.
Surgical Relief of Intractable Pain
Collaborators: FRANCIS C. GRANT, M.D., F.A.C.S., Philadelphia; WILLIAM H. SWEET, M.D., Boston; JAMES W. WATTS, M.D., F.A.C.S., Washington, D.C.
Moderator: JOHN E. SCARFF, M.D., F.A.C.S., New York.
Evaluation of the Results of Surgical Procedures Undertaken for the Relief of Psychoses
Collaborators: LOTHAR B. KALINOWSKY, M.D., New York; JAMES L. POPPEN, M.D., F.A.C.S., Boston; HARRY C. SOLOMON, M.D., Boston; J. LAWRENCE POOL, M.D., F.A.C.S., New York; PAUL H. HOCH, M.D., New York; WILLIAM B. SCOVILLE, M.D., Hartford; EDWARD WILK, M.D., Middletown, Connecticut; WALTER FREEMAN, M.D., Ph.D., Washington, D.C.; HENRY WYCIS, M.D., F.A.C.S., Philadelphia; ERNEST A. SPIEGEL, M.D., Philadelphia.

SYMPOSIUM ON SPORTS INJURIES

Tuesday, 10:00 a.m.—12:00 m.—Grand Hall, Mechanics Building

CLINICOPATHOLOGICAL CONFERENCE

Wednesday, 10:30 a.m.—12:00 m.—Grand Hall, Mechanics Building

Conducted by: TRACY BURR MALLORY, M.D., Boston

SYMPOSIUM ON CANCER

Wednesday, 2:00—5:00 p.m.—Ballroom, Copley Plaza Hotel

GRANTLEY W. TAYLOR, M.D., F.A.C.S., Boston, *Presiding.*
The Morphologic Classification and Clinical Follow-up Study of 1000 Testicular Tumors. FRANK J. DIXON, M.D., St. Louis.
Surgery of the Breast. FRANK E. ADAIR, M.D., F.A.C.S., New York.
Radiation Therapy of Breast Malignancies. MANUEL GARCIA, M.D., New Orleans.
Cancer of the Esophagus. ALTON OCHSNER, M.D., F.A.C.S., New Orleans.
Cancer Control in the United States: A Progress Report. CHARLES S. CAMERON, M.D., F.A.C.S., New York.
Diagnostic Tests for Cancer. STUART W. LIPPINCOTT, M.D., Seattle.
Report, Subcommittee on Standardization of Publishing Cancer End Results. ERNEST M. DALAND, M.D., F.A.C.S., Boston.

SYMPOSIUM ON TRAUMA

Thursday, 9:00 a.m.—12:00 m.—Grand Hall, Mechanics Building

ROBERT H. KENNEDY, M.D., F.A.C.S., New York, *Presiding.*
Practical Surgery in Head Trauma. A. EARL WALKER, M.D., F.A.C.S., Baltimore.
Nonpenetrating Injuries of the Abdomen. ROBERT P. DOBBIE, M.D., F.A.C.S., Buffalo.
Prevention, Treatment Cicatricial Contractures of the Joints. HANS MAY, M.D., F.A.C.S., Philadelphia.
Injury to the Nerves of the Hand—Primary and Secondary Neurorrhaphy. VINTON E. SILER, M.D., F.A.C.S., Cincinnati.
Pathological Fractures. WILLIAM H. BICKEL, M.D., F.A.C.S., Rochester, Minnesota.
Fractures of the Medial Malleolus. SAM W. BANKS, M.D., F.A.C.S., Chicago.
Fractures of Both Bones of the Forearm. FREDERICK M. SMITH, M.D., F.A.C.S., New York.
Results from the Use of Refrigerated Homogenous Bone Grafts in Surgical Procedures. PHILIP D. WILSON, M.D., F.A.C.S., New York.

SYMPOSIUM ON GRADUATE TRAINING IN SURGERY AND THE SURGICAL SPECIALTIES

Thursday, 1:30—3:00 p.m.—Georgian Room, Hotel Statler

FREDERICK A. COLLER, M.D., F.A.C.S., Ann Arbor, *Presiding.*
The Possibilities for Graduate Training in the Smaller Hospitals and Special Problems Involved. THOMAS J. SUMMEY, M.D., F.A.C.S., Mount Holly, New Jersey.
Suggestions on Graduate Training. W. PAT FITE, M.D., F.A.C.S., Muskogee, Oklahoma.
The Educational Content of the Years of Surgical Training. CALVIN M. SMYTH, Jr., M.D., F.A.C.S., Rydal, Pennsylvania.

ANNUAL MEETING—BOARD OF GOVERNORS

Monday, 12:45 Noon—Luncheon—to 5:00 p.m. Georgian Room and Parlor A, Hotel Statler

WILLIAM L. ESTES, Jr., M.D., F.A.C.S., Bethlehem, Pennsylvania, Temporary Chairman, *Presiding.*
Presentation of the Program for the Governors. The Chairman
Election of Officers of the Board of Governors—(a) Chairman, (b) Vice Chairman, (c) Secretary.
Election of the Executive Committee of the Board of Governors
Selection of Advisory Committee on Nominations
Statement Concerning Governors Who Are Nominees of Special Societies or Federal Services
The Board Diplomate and the College
Report on the College Program. PAUL R. HAWLEY, M.D., Chicago, The Director, American College of Surgeons.
General Discussion by the Governors
Announcement of Meeting—Credentials, Judiciary, and Counseling Committees, 10:00 A.M., October 25
Announcement Concerning Adjourned Meetings of the Board of Governors

ADJOURNED MEETING—BOARD OF GOVERNORS

Thursday, 3:30—3:45 p.m.—Ballroom, Copley Plaza Hotel

ANNUAL MEETING OF FELLOWS

Thursday, 3:45—6:00 p.m.—Ballroom, Copley Plaza Hotel

The Board of Regents of the American College of Surgeons has requested that the annual reports of various committees and departments of the College be published each year in advance of the Annual Meeting of Fellows—in the September BULLETIN which is mailed to each Fellow the last week in September.

Agenda

Report of the Nominating Committee: Officers of the College; Governors of the College
Deliberations of the Board of Governors—1950 Annual Meeting.
Report of the Treasurer. WARREN H. COLE, M.D., F.A.C.S., Chicago; Treasurer
Cancer Committee. GRANTLEY W. TAYLOR, M.D., F.A.C.S., Boston; Chairman
Committee on Trauma. ROBERT H. KENNEDY, M.D., F.A.C.S., New York; Chairman
Committee on Graduate Training in Surgery. FREDERICK A. COLLER, M.D., F.A.C.S., Ann Arbor; Chairman
Committee on Medical Motion Pictures. CHARLES B. PUESTOW, M.D., F.A.C.S., Chicago; Chairman
Committee on Nutrition of the Surgical Patient. I. S. RAVDIN, M.D., F.A.C.S., Philadelphia; Chairman
The American College of Surgeons—Summary of Annual Reports of Departments and Committees. PAUL R. HAWLEY, M.D., Chicago; The Director, American College of Surgeons
General Discussion

MEETING OF STATE AND PROVINCIAL COUNSELING COMMITTEES,* CREDENTIALS COMMITTEES, COMMITTEES ON APPLICANTS AND JUDICIARY COMMITTEES

Wednesday, 10:00 a.m.—12:00 m.—Sheraton Room—Copley Plaza Hotel

ARTHUR W. ALLEN, M.D., F.A.C.S., Boston; Chairman, Board of Regents, *Presiding*
The Role of these Committees in Elevating the Prestige of the College. PAUL R. HAWLEY, M.D., Chicago; Director, American College of Surgeons
Consideration of Applicants for the Junior and Senior Candidate Groups and for Fellowship. H. PRATHER SAUNDERS, M.D., F.A.C.S., Chicago; Associate Director, American College of Surgeons
Discussion. J. WILLIAM HINTON, M.D., F.A.C.S., New York City; LAWRENCE CHAFFIN, M.D., F.A.C.S., Los Angeles; ROBERT T. ALLISON, M.D., F.A.C.S., Akron; NEWELL W. PHILPOTT, M.D., F.A.C.S., Montreal
Question and Answer Period

*Formerly State and Provincial Executive Committees

TWENTY-NINTH ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

Monday, 10:00 a.m.—12:00 m.—Grand Hall, Mechanics Building

General Assembly—For Surgeons, Physicians, Hospital Representatives, and Others (See program on earlier page).

2:00—5:00 p.m.—Ballroom Assembly, Hotel Statler

Theme: The Voluntary Hospital.
PAUL J. SPENCER, Lowell, *Presiding*
Opening Address of the Hospital Conference
The Voluntary Hospital—Part and Parcel of our Way of Life—Must be Retained.
Looking Forward with Blue Cross and Blue Shield Plans
Co-operation of Governmental and Voluntary Agencies in the Care of the Sick and Prevention of Disease.
Present and Future Trends in Patient-Day Costs.
Speakers: WARREN F. COOK, D.D., Boston; The Reverend DONALD MCGOWAN, Washington, D.C.; E. DWIGHT BARNETT, M.D., Detroit; CHARLES F. WILINSKY, M.D., Boston; OLIVER G. PRATT, Providence.

8:30—10:00 p.m.—Grand Ballroom, Hotel Statler

Presidential Meeting (See program on earlier page).

Tuesday—10:00 a.m.—12:30 p.m.—Georgian Room, Hotel Statler

Theme: Advances in the Management of the Surgical Department and Promotion of Safe-Practices in the Operating Room.
WILMAR M. ALLEN, M.D., Hartford, *Presiding*
Planning the Operating Room from the Functional Standpoint.
Elimination of Operating Room Hazards and Safe Practices in Handling Anesthetics.
Control of Infections Through Safe Operating Room Management and Technical Procedures
Speakers: MADISON B. BROWN, M.D., New York; GEORGE H. BUCK, Baltimore; CARL W. WALTER, M.D., F.A.C.S., Boston

2:00—5:00 p.m.—Georgian Room, Hotel Statler

CHARLES B. PUESTOW, M.D., F.A.C.S., Chicago, *Presiding*
Theme: Teamwork in the Operating Room—Basic Factors in Assuring Efficiency—Discussion from the Viewpoint of:

The Surgeon	The Anesthetist
The Assistant	The Pathologist
The Surgical Supervisor	The Medical Secretary

Speakers: ROBERT L. SANDERS, M.D., F.A.C.S., Memphis; SUMNER L. KOCH, M.D., F.A.C.S., Chicago; FLORENCE A. SOUSA, R.N., Boston; CURTISS B. HICKCOX, M.D., Hartford; CHARLES F. BRANCH, M.D., Lewiston, Maine; E. LOUISE SEYMOUR, R.R.L., Boston.

7:45—10:00 p.m.—Georgian Room—Hotel Statler

DEAN A. CLARK, M.D., Boston, *Presiding*
Theme: Trends in World Health and the Care of the Sick and Injured—from the Standpoint of:
The World Health Organization.
The World Medical Association.
International Hospital Federation.
Speakers: WILLIAM FORREST, M.D., Geneva, Switzerland; ELMER L. HENDERSON, M.D., F.A.C.S., Louisville; DONALD C. SMELZER, M.D., Philadelphia.

Wednesday, 7:45—9:30 a.m.—Bay State Room, Hotel Statler

Theme: The Hospital in the News and on the Air.
OLIVER G. PRATT, Providence, *Presiding*
Radio as a Public Educational Medium for Hospital and Medical Developments
The Science Writer's Viewpoint.
Medicine, Hospitals, and the Press.
Speakers: LELAND BICKFORD, Boston; WILLIAM LAURENCE, New York; ELEANOR R. COLLIER, Boston.

10:00 a.m.—12:30 p.m.—Georgian Room, Hotel Statler

ROBIN C. BUERKI, M.D., Philadelphia, *Presiding.*
Theme: Trends in Standards for Special Hospitals from the Viewpoint of:

Geriatrics; Psychiatry; Tuberculosis; Physical Medicine.
Speakers: A. P. MERRILL, M.D., New York; MESROP A. TARUMIANZ, Farnhurst, Delaware; RUSSELL S. ANDERSON, M.D., Erie; FREDERIC T. JUNG, M.D., Chicago.

2:00–5:00 p.m.—Georgian Room, Hotel Statler

Joint Session with the American Association of Medical Records Librarians
JOSEPH C. DOANE, M.D., Philadelphia, *Presiding.*
Looking Forward with the Medical Record Librarian—A Message from Grace Myers, Honorary President and Co-Founder of the American Association of Medical Record Librarians.
Medical Records—25 years in Retrospect.
Responsibility for Teaching Medical Record Keeping from the Viewpoint of the Medical School.
Study of Neonatal Deaths in the Hospital.
The Medical Record in Court. The Medical Audit.
Speakers: GRACE MYERS, R.R.L., Newton Highlands, Massachusetts; MALCOLM T. MACEACHERN, M.D., D.Sc., Chicago; ROBIN C. BUERKI, M.D., Philadelphia; E. H. L. CORWIN, Ph.D., New York; PETER B. TERENZIO, LL.B., New York; FREDERICK T. HILL, M.D., F.A.C.S., Waterville, Maine; JOHN R. ORNDORFF, M.D., F.A.C.S., Chicago.

2:00–5:00 p.m.—Peter Bent Brigham Hospital

Demonstration—Control of the Explosion Hazard in the Operating Room
Conducted by: CARL W. WALTER, M. D., F.A.C.S., Boston.

7:45–10:00 p.m.—Georgian Room, Hotel Statler

Preparedness for National Emergencies
Moderator: FRANK H. LAHEY, M.D., F.A.C.S., Boston.
Collaborators: RAYMOND W. BLISS, M.D., F.A.C.S., (M.C., U.S.A.), Washington, D.C.; Vice Admiral Ross T. MCINTIRE, M.D., F.A.C.S., (M.C., U.S.N.), Washington, D.C.; JAMES C. SARGENT, M.D., F.A.C.S., Milwaukee; CHARLES F. WILINSKY, M.D., Boston.

Thursday

7:45–9:30 a.m.—Bay State Room, Hotel Statler

Get Together Breakfast and Conference for Hospital Administration Residents and Graduates
Theme: Informal and Voluntary Discussion of Experience in a New World of Action
Conducted by: FRANK R. BRADLEY, M.D., St. Louis.

9:30 a.m.–12:30 p.m.—Bay State Room, Hotel Statler

A Forum on Trends in Hospital Administration, New Ideas and Procedures and Special Hospital Problems.
Conducted by: FRANK R. BRADLEY, M.D., St. Louis.
Opportunity has been given to the graduates and administrative residents of the various universities offering courses in hospital administration to present summary transcripts of new trends in hospital work. The subjects listed were chosen from the transcripts submitted.
Complaints and What the Administrator Should Do About Them.
Human Relations at Work in our Hospitals.
Public Relations in the Nursery.
Compiling the Administrative Manual.
Combined In-patient and Out-patient Ambulant Admission Ledger.
Impact of Aging Population on Hospital Practices.
Administrative Handling of Mass Casualties.
The Administrative Residency—Foundation for the Future.
Progressive Hospital Administration and Community Health.
Speakers: GEORGE S. BUIS, New Haven; JOHN N. BOWDEN, M.D., F.A.C.S., Cleveland; HAROLD P. ALDEN, San Francisco; CLARENCE W. BUSHNELL, Boston; WESLEY D. SPRAGUE, Newton Lower Falls; NEWMAN M. BILLER, New York; Major HOWARD R. SCROGGS, M.S.C., Fort Sam Houston, Texas, JEROME T. BIETER, Providence; HENRY AMICARELLA, Denver.

2:00–5:00 p.m.—Bay State Room, Hotel Statler

Theme: Ways and Means in Maintaining Professional Standards and Other Services for Patients in Rural and Small Hospitals.
D. ALLAN CRAIG, M.D., New York, *Presiding.*
Panel of Speakers from: United States Public Health Service (VANE M. HOGE, M.D., Washington, D.C.); Duke Endowment (MARSHALL I. PICKENS, Charlotte, North Carolina); Bingham Associates (BROOKS RYDER, M.D., Boston); Mississippi Commission on Hospital Care (D. V. GALLOWAY, M.D., Jackson); Georgia Chapter, American College of Surgeons (DAVID H. POER, M.D., F.A.C.S , Atlanta).

2:00–5:00 p.m.—Peter Bent Brigham Hospital

Demonstration—Sterilization and Aseptic Technic as Demonstrated to Second Year Surgery Students, Harvard Medical School

Conducted by CARL W. WALTER, M.D., F.A.C.S., Boston.

7:45–10:00 p.m.—Bay State Room, Hotel Statler

Joint Session—Hospital Administrators, Members of Medical Staffs and Nurses.

Theme: Nursing Care of the Patient in Peacetime and in National Emergency.

RUTH SLEEPER, R.N., Boston, *Presiding.*

The Present Status of Nursing Throughout the United States.

The Present Status of Nursing Throughout Canada

Preparedness for a National Emergency

Correlation and Coordination of the Various Groups on Different Working Levels Involved in the Nursing Care of the Patient.

Friday

10:00 a.m.–4:00 p.m.

Visiting Boston Hospitals

8:30–10:00 p.m.—Symphony Hall

Convocation (See program on earlier page)

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

Monday, 2:00 p.m.–5:00 p.m., Tuesday and Wednesday, 9:00 a.m.–12:00 m. and 2:00 p.m.–5:00 p.m., Thursday, 9:00 a.m.–12:00 m. and 1:15 p.m.–3:20 p.m. and Friday, 9:00 a.m.–12:00 m.

Cardiac Surgery

2:00 p.m. Monday—Ballroom, Hotel Statler

ROBERT E. GROSS, M.D., F.A.C.S., Boston; Assistant Professor of Surgery, Harvard Medical School, Presiding.

The Circulation Time During Manual Massage of the Arrested Dog's Heart. P. F. WARE, M.D., J. R. STANTON, M.D., W. E. JUDSON, M.D., J. W. STUTZMAN, M.D., Boston. Departments of Surgery, Medicine and Pharmacology, Boston University School of Medicine and Massachusetts Memorial Hospitals; Surgical Service, The Memorial Hospital and St. Vincent Hospital, Worcester.

A Method for the Prevention of Ventricular Fibrillation During Operation on the Heart. ALEXANDER H. BILL, JR., M.D. and JACOB C. WAGNER, M.D., Seattle. Department of Surgery, University of Washington School of Medicine.

An Electrical Artificial Pacemaker for Standstill of the Heart. J. C. CALLAGHAN, M.D., W. G. BIGELOW, M.D., Toronto. Department of Surgery, University of Toronto Faculty of Medicine.

The State of the Circulation During Ventricular Fibrillation. JAMES L. SOUTHWORTH, M.D., F.A.C.S., E. CONVERSE PEIRCE II, M.D., FREEMAN L. RAWSON, JR., M.D., VICTOR A. MCKUSICK, M.D., Baltimore. Cardiovascular Clinic (Clinic of General Medicine and Experimental Therapeutics of the National Heart Institute), U.S. Marine Hospital.

Artificial Maintenance of the Circulation. SIGMUND A. WESOLOWSKI, M.D., C. STUART WELCH, M.D., Boston. Department of Surgery, Tufts College Medical School and New England Center Hospital.

The Shunting of Blood From the Right Heart by Means of a Pump with Operations on the Interior of the Heart. SANFORD E. LEEDS, M.D., F.A.C.S., IRVING PUZISS, M.D., DAVID SIEGEL, M.D., San Francisco. Harold Brunn Institute for Cardiovascular Research, Mount Zion Hospital.

Experimental Cardiac Surgery. II. Further Observations on the Development of a Perfusion Pump for the Purpose of Shunting the Venous Return Directly Into the Pulmonary Artery WILLIAM H. SEWELL, JR., M.D., WILLIAM W. L. GLENN, M.D., New Haven. Department of Surgery, Yale University School of Medicine.

The Experimental Production and Correction of Mitral Stenosis. JOHN E. CONNOLLY, M.D., San Francisco. Stanford University Hospitals and Laboratory for Experimental Surgery, Stanford University School of Medicine.

A Method for the Correction of Pulmonary Stenosis. C. A. HUFNAGEL, M.D., Boston. Laboratory for Surgical Research, Harvard Medical School and Surgical Service, Peter Bent Brigham Hospital.

A Plastic Prosthesis (Without Moving Parts) for the Atrioventricular Valves. G. REHMI DENTON, M.D., Albany. Research Laboratories of the Departments of Experimental Surgery, Physiology and Pharmacology, Albany Medical College.

Observations on the Use of an Experimental Artificial Left Heart. ADRIAN KANTROWITZ, M.D., ARTHUR KANTROWITZ, Ph.D., Ithaca. Surgical Service of Montefiore Hospital and Graduate School of Aeronautical Engineering, Cornell University.

Experimental Exposure for Operation upon the Mitral Valve. GEORGE H. A. CLOWES, JR., M.D., JOHN HUNTER, Ph.D., ROBERT W. ROBERTSON, M.D., Toronto. Department of Surgery and Banting and Best Department of Medical Research, University of Toronto Faculty of Medicine.

Experimental Ascites. HARRY G. PARSONS, M.D., EMILE HOLMAN, M.D., San Francisco. Stanford University School of Medicine.

Observations on the Healing of the Myocardium. C. G. THOMAS, JR., M.D., S. E. ZIFFREN, M.D., Iowa City. Department of Surgery, State University of Iowa College of Medicine.

Regression of Cardiac Hypertrophy: Changes in Cardiac Muscle Fiber Diameters After the Production and Excision of Arteriovenous Fistulas. LOUIS SHAFFNER, M.D., H. H. BRADSHAW, M.D., Winston-Salem. Department of Surgery, Bowman Gray School of Medicine of Wake Forest College.

Peritoneum, Small and Large Bowel and Pancreas

9:00 a.m., Tuesday—Ballroom, Hotel Statler

I. S. RAVDIN, M.D., F.A.C.S., Philadelphia; John Rhea Barton Professor of Surgery, University of Pennsylvania Medical School, Presiding.

A Study of the Liver Lymph in Experimental Peritonitis of Intestinal Origin. RICHARD GARDNER, M.D., ROBERT JOHANSEN, M.D., MAURICE GALANTE, M.D., H. J. MCCORKLE, M.D., F.A.C.S., San Francisco. Experimental Surgery Laboratories, University of California School of Medicine.

The Relationship of Plasma Proteolytic Enzymes to the Course of Experimental Appendiceal Peritonitis. RICHARD F. GRISE, M.D., E. MEREDITH ALRICH, M.D., EDWIN P. LEHMAN, M.D., Charlottesville. University of Virginia School of Surgery and Gynecology.

Studies on the Use of Terramycin in Experimental and Clinical Peritonitis. Lieutenant Colonel E. J. PULASKI, M.C., F.A.C.S., Colonel JOSEPH R. SHAEFFER, M.C., F.A.C.S , Captain CURTIS ARTS, M.C., Major HINTON J. BAKER, M.C., Fort Sam Houston, Texas. Brooke General Hospital, Brooke Army Medical Center.

A Study of Factors Affecting the Development and Persistence of Intraperitoneal Adhesions in Experimental Animals (Including Streptokinase, Dornase, Cortisone and Antibiotics). JOHN W. THOMAS, M.D., J. E. RHOADS, M.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania School of Medicine.

Recovery of Bacterial Enzymes From the Thoracic Duct in Experimental Strangulation Obstruction. HAROLD LAUFMAN, M.D., Ph.D., F.A.C.S., CARLOS A. TANTURI, M.D., M.S., Chicago. Department of Surgery, Northwestern University Medical School.

The Effect of Parasympathetic Denervation upon the Intestinal Action of Atropine. R. M. WHITROCK, M.D., G. K. MOE, M.D., G. W. GRAY, Ann Arbor. Departments of Surgery and Pharmacology, University of Michigan Medical School.

Denervation of the Pelvic Colon for Ulcerative Colitis. BENJAMIN G. P. SHAFIROFF, M.D., F.A.C.S , New York. Department of Surgery, New York University Medical School.

The Mechanism of Bladder Dysfunction Following Abdominoperineal Resection of the Rectum. GEORGE W. FLINT, M.D., HAROLD HERMANN, M.D., CHARLES B. RIPSTEIN, M.D., New York. Department of Surgery, Maimonides Hospital and State University Medical Center.

The Effect of Bile and Pancreatic Juice on the Colon: a Possible Factor in the Etiology of Chronic Ulcerative Colitis. DONALD J. CURRIE, M.D., D. R. WEBSTER, M.D., Ph.D., F.R.C.S.(C), Montreal. Department of Experimental Surgery, McGill University Faculty of Medicine.

Pancreatic Secretions and Response to Secretin After Vagotomy and Sympathectomy. WILLIAM W. SHINGLETON, M.D., BLAKE W FAWCETT, M.D., J S. VETTER, Durham. Department of Surgery, Duke University School of Medicine.

The Influence of the Autonomic Nervous System on the Course of Experimental Acute Pancreatitis. CHARLES B. RIPSTEIN, M.D., ALAN G. THOMPSON, M.D., New York. Department of Surgery, Maimonides Hospital and State University Medical Center; Department of Experimental Surgery, McGill University Faculty of Medicine, Montreal.

Trypsin and Antitrypsin in Acute Pancreatic Disease. ROBERT J. COFFEY, M.D., F.A.C.S., F. JOSEPH BRINIG, M.D., JOHN GILLESPIE, M.D., Washington, D.C. Department of Surgery, University Hospital, Georgetown University Medical Center.

Surgery of the Lung and Esophagus

9:00 a.m., Tuesday—Ballroom Assembly, Hotel Statler

RICHARD H. OVERHOLT, M.D., F.A.C.S., Boston, John Homans Professor of Clinical Surgery, Tufts College Medical School, Presiding.

One Stage Costoversion Thoracoplasty. RICHARD H. OVERHOLT, M.D., F.A.C.S., LEO J. KENNEY, M.D., Boston. Department of Surgery, Tufts College Medical School.

The Production of Maximum Ventilation and Its Limitation in Pulmonary Disease. DONALD F. PROCTOR, M.D , F.A.C.S., JAMES P. ISAACS, M.D., BURR NOLAND CARTER III, Baltimore. Department of Otolaryngology, Johns Hopkins Medical School.

A Study of the Effect of Decreasing the Amount of Lung Tissue on the Right Ventricular Pressures in Animals. RALPH F. CARLSON, M.D., BERNARD C. CHARBON, M.D., HARMIA G. A. CHARBON, M.D., W. E. ADAMS, M.D., Chicago. Department of Surgery, University of Chicago School of Medicine.

Clinical and Experimental Studies with a Water-Soluble Agent for Bronchography. MORDANT E. PECK, M.D., A. J. NEERKEN, M.D., EMANUEL SALZMAN, M.D., Denver. Department of Surgery, University of Colorado School of Medicine.

The Effect of Lipiodol on Alveolar Gas Exchange. HARRISON BLACK, M.D., ALBERT ROOS, M.D., St. Louis. Laboratory of Applied Thoracic Physiology, Department of Surgery, Washington University School of Medicine.

Tryptic Débridement in Fibrinepurulent Empyema. HOWARD G. REISER, M.D., L. C. ROETTIG, M.D., F.A.C.S., GEORGE E. CURTIS, M.D., F.A C.S., Columbus. Department of Research Surgery, Ohio State University College of Medicine.

The Effect of Alterations in Pulmonary Circulation on Collateral Ventilation. JAY L. ANKENEY, M.D., CHARLES A. HUBAY, M.D., FRED W. TILLOTSOM, M.D., Cleveland. Departments of Surgical Research and Pathology, Western Reserve University School of Medicine.

Bilateral Bronchiectasis: Pulmonary Function Following Unilateral or Bilateral Pulmonary Resection. E. P. MANNIX, JR., M.D., C. E. O'BRIEN, M.D., W. A. MCALPINE, M.D., R. H. ADLER, M.D., Ann Arbor. Department of Surgery, University of Michigan Medical School.

Resection of the Lower Trachea and Bifurcation; an Experimental Study. JOHN R. GRINDLAY, M.D., F.A.C.S., HERMAN J. MOERSCH, M.D., O. THERON CLAGETT, M.D., Rochester. Division of Experimental Medicine, Mayo Clinic.

Repair of Experimental Complete Tracheal Defects with Fresh and Preserved Grafts. ORLAND DAVIES, M.D., J. MALCOLM EDMISTON, M.D., H. J. MCCORKLE, M.D., F.A.C.S., San Francisco. Experimental Surgery Laboratories, University of California School of Medicine.

The Homotransplantation of Tracheas in Dogs. VICTOR RICHARDS, M.D., F.A.C.S., JOHN E. CONNOLLY, M.D., San Francisco. Stanford University Hospitals and Laboratory for Experimental Surgery, Stanford University School of Medicine.

Anastomosis of the Thoracic Esophagus: III. Experimental Evaluation of Peritoneal Grafts, One-Layer Anastomosis. HAROLD WARSHAW, M.D., LEROY J. KLEINSASSER, M.D., F.A.C.S., Dallas. Department of Surgery, Veterans Administration Hospital and Southwestern Medical College of the University of Texas.

Experimental Production of Esophagitis and Esophageal Ulcers in Dogs. ROBERTO ARROYAVE, M.D., H. WILLIAM CLATWORTHY, JR., M.D., Minneapolis. Department of Surgery, University of Minnesota Medical School.

The Pathology of Experimentally Produced Lye Strictures of the Esophagus. LEWIS H. BOSHER, JR., M.D. and THOMAS H. BURFORD, M.D., LAUREN V. ACKERMAN, M.D., St. Louis. Department of Surgery, Washington University School of Medicine and Chest Surgical Service, Barnes Hospital.

Blood Transfusion, Coagulation, Shock and Hemorrhage

2:00 p.m., Tuesday—Ballroom, Hotel Statler

FRANCIS D. MOORE, M.D., F.A.C.S., Boston; Moseley Professor of Surgery, Harvard Medical School, Presiding.

Observations on Low Temperature and High Pressure as a Means Toward Better Red Blood Cell Preservation. A. G. JESSIMAN, M.D., F.R.C.S., CARL W. WALTER, M.D., F.A C.S., Boston. Surgical Services and Laboratories, Harvard Medical School at Peter Bent Brigham Hospital.

A New Technique for Collection and Storage of Unadulterated Whole Blood. CARL W. WALTER, M.D., F.A.C.S., Boston. Department of Surgery, Harvard Medical School.

Heparin-Dextrose Preserved Blood for Blood Transfusion. J. HUSTON WESTOVER, M.D., DAVID V. HABIF, M.D., JOHN SCUDDER, M.D., New York. Department of Surgery, Columbia University College of Physicians and Surgeons.

Blood Preservation. ANGIE S. HAMILTON, M.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania School of Medicine.

Evidence Against Trueta Renal Vascular Shunts in Incompatible Blood Transfusion Anuria. HAROLD G. BARKER, M.D., JOHN K. CLARK, M.D., ARCHER P. CROSLEY, JR., M.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania School of Medicine and Pepper Laboratory of the University Hospital.

Intra-Arterial Transfusion. E. MEREDITH ALRICH, M.D., C BRUCE MORTON, II., M.D., Charlottesville. University of Virginia School of Surgery and Gynecology

Blood Coagulation as Effected by ACTH and Surgical Stress. R. R. MARGULIS, M.D., Detroit. Henry Ford Hospital.

A Study of the Clotting Mechanism in Thermal Burns. DARRELL A. CAMPBELL, M.D., F.A.C.S., LOUIS T. GABRIEL, JR., DONALD E. VAN HOEK, M.D., Eloise, Michigan. Department of Surgery, Wayne County General Hospital.

The Intestinal Absorption of Oral Antibiotics in Traumatic Shock—an Experimental Study. WILLIAM A. ALTEMEIER, M.D., F.A.C.S., WILLIAM R. CULBERTSON, M.D., Cincinnati. Department of Surgery, University of Cincinnati College of Medicine and Cincinnati General Hospital.

Changes in the Metabolism of Cardiac Muscle in Shock. WALTER J. BURDETTE, Ph.D., M.D., New Orleans. Department of Surgery, Louisiana State University School of Medicine.

A Study of Internal Water Exchange Rates Following Hemorrhage. M. J. FOGELMAN, M.D., P. O'B. MONTGOMERY, M.D. and C. A. MOYER, M.D., F.A.C.S., Dallas. Department of Experimental Surgery, Southwestern Medical School of the University of Texas.

ACTH and Cortisone Therapy in Experimental Hemorrhagic Shock and the Hepatic Vascular Resistance in Relation to Shock. HOWARD A. FRANK, M.D., F.A.C.S., JACOB FINE, M.D., EDWARD FRIEDMAN, M.D., PHILIP GLOTZER, M.D., STANLEY JACOBS, M.D., and ALVIN SCHWARTZ, M.D., Boston. Department of Surgical Research, Beth Israel Hospital.

Blood Vascular System and Blood Flow

9:00 a.m., Wednesday—Ballroom Assembly, Hotel Statler

REGINALD H. SMITHWICK, M.D., F.A.C.S., Boston; Professor of Surgery, Boston University School of Medicine, Presiding.

Experimental Studies in Delayed Heterologous Arterial Grafting Utilizing an Intra-Arterial Tube Shunt. PAUL T. DECAMP, M.D., ROWENA SPENCER, M.D., JOHN W. OVERSTREET, M.D., New Orleans. Department of Surgery, Tulane University School of Medicine.

Frozen Arterial Homotransplants, an Experimental Study. H. H. G. EASTCOTT, M.D., F.R.C.S., C. A. HUFNAGEL, M.D., Boston. Surgical Services and Laboratories of Harvard Medical School at Peter Bent Brigham Hospital.

The Use of Frozen Homologous Aortic Grafts in Dogs. R. A. DETERLING, JR., M.D., Ph.D., C. C. COLEMAN, JR., M.D., MARY PARSHLEY, Ph.D., New York. Department of Surgery, Columbia University College of Physicians and Surgeons.

The Relationship of the Method of Suture to the Growth of Aortic Anastomoses. Vein Grafts and Artery Grafts. JULIAN JOHNSON, M.D., CHARLES K. KIRBY, M.D., W. H. HAGAN, M.D., M. W. ALLAM, V.M.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania School of Medicine and School of Veterinary Medicine.

The Effect of Arteriovenous Fistulas Upon Pulmonary Arterial Pressure. C. W. LILLEHEI, M.D., J. R. BOBB, M.D., M. B. VISSCHER, M.D., Minneapolis. Departments of Surgery and Physiology, University of Minnesota School of Medicine.

Experimental Pulmonary Arteriovenous Fistula. TIMOTHY TAKARO, M.D., H. E. ESSEX, Ph.D., H. B. BURCHELL, M.D., Rochester. Mayo Foundation for Medical Education and Research.

The Fate of an Artery Implanted in the Myocardium. FRANK GLENN, M.D., F.A.C.S., GEORGE R. HOLSWADE, M.D., ARTHUR L. CORE, M.D., New York. Department of Surgery, New York Hospital of Cornell University Medical College.

A Study of the Physiological Role of an Anastomosis Between the Coronary Circulation and the Left Internal Mammary Artery Implanted in the Ventricular Myocardium. W. D. MILLER, M.D., ARTHUR M. VINEBERG, M.D., Montreal. Experimental Surgical Laboratories, McGill University Faculty of Medicine.

Observations on the Fate of Pericardial and Fascial Tissue Transplanted Into the Thoracic Aorta. Y. SAKO, M.D., H. WILLIAM CLATWORTHY, M.D., TAGUE CHISHOLM, M.D., RICHARD L. VARGO, M.D., Minneapolis. Department of Surgery, University of Minnesota Medical School.

Oscillometric Observations in Venous Occlusive Disease. RICHARD W. ZOLLINGER, M.D., F.A.C.S., LUTHER M. KEITH, JR., M.D., Columbus. Peripheral Vascular Clinic and the Surgical Service, University Hospital, Ohio State University College of Medicine.

The Late Sequelae of Vena Cava Ligation. PATRICK C. SHEA, JR., M.D., ROY L. ROBERTSON, M.D., Atlanta. Whitehead Department of Surgery, Emory University School of Medicine.

Electromagnetic Measurement of Blood Flow. M. M. NEWMAN, M.D., E. B. BAY, M.D., A. KOLIN, Ph.D., W. E. ADAMS, M.D., Chicago. Department of Surgery, University of Chicago School of Medicine.

Stomach

9:00 a.m., Wednesday—Ballroom, Hotel Statler

OWEN H. WANGENSTEEN, M.D., F.A.C.S., Minneapolis; Professor of Surgery, University of Minnesota Medical School, Presiding.

Measurement of Electropotentials of the Stomach. I. S. RAVIN, M.D., J. J. KNEISEL, JR., M.D., RICHARD TAYLOR, M.S., HENRY M. LEMON, M.D., E. M. THOMPSON, M.D., R. H. SMITHWICK, M.D., F.A.C.S., Boston. Departments of Medicine and Surgery, Boston University School of Medicine, Massachusetts Memorial Hospitals and Department of Electrical Engineering, Massachusetts Institute of Technology, Cambridge.

Re-Examination of Indications for Surgery for Peptic Ulcer. K. S. GRIMSON, M.D., F.A.C.S., C. K. LYONS, M.D., B. H. FLOWE, M.D., Durham. Department of Surgery, Duke University School of Medicine.

Some Effects of Vagotomy on Gastric Secretion as Studied in Dogs with Gastric Pouches. R. T. HOOD, JR., M.D., C. F. CODE, M.D., Rochester. Mayo Foundation for Medical Education and Research.

The Effect of Subtotal Gastric Resection and Bilateral Vagectomy upon the Secretion of Gastric Mucin and Its Fractions in Man, as Tested by Insulin Stimulation. GEORGE B. JERZY GLASS, M.D., WALTER L. MERSHEIMER, M.D., F.A.C.S., CHESTER S. SVIGALS, M.D., Departments of Medicine and Surgery, New York Medical College, New York.

Effects of Vagus Nerve Resection with Subtotal Gastrectomy upon the Development of the Mann-Williamson Ulcer. JAMES V. OLIVER, M.D., M.S., F.A.C.S., Chicago. University of Illinois College of Medicine.

Gastroesophageal Anastomosis with and without Vagotomy; an Experimental Study. ALFONSO TOPETE, M.D., ROBERTO MENDIOLA, M.D., ROBERTO VAZQUEZ PALLARES, M.D., MIGUEL CASTELLANOS, M.D., ADOLFO FLORES, M.D., HUMBERTO TORRES, M.D., ELISA LOMELI, W. E. ADAMS, B.S., M.D., F.A.C.S., Chicago. Departments of Surgery and Pathology, University of Guadalajara Faculty of Medicine, Mexico, and Department of Surgery, University of Chicago School of Medicine.

Studies on Gastrin from Normal and Abnormal Human Stomachs. D. J. FERGUSON, M.D., Minneapolis. Department of Surgery, University of Minnesota Medical School.

Relationship of the Length of the Afferent Loop to the Incidence of Histamine-Induced Jejunal Ulcer in Gastrectomized Dogs. HENRY W. MAYO, JR., M.D., Charleston. Medical College of the State of South Carolina.

Effect of Prepyloric Deviation of Alkaline Secretions on Histamine Ulcers in Dogs. GEORGE C. BLANCHARD, M.D., Augusta. Department of Surgery, University of Georgia School of Medicine.

The Effect of Pyridoxine Deficiency on Gastric Secretion and Blood. R. ARMOUR FORSE, M.D., D. R. WEBSTER, M.D., Ph.D., F.R.C.S.(C), Montreal. Department of Experimental Surgery, McGill University Faculty of Medicine.

The Effect of Banthine on Canine Pancreatic Secretion. DAVID ANNIS, M.D., GEORGE A. HALLENBECK, M.D., Rochester. Mayo Foundation for Medical Education and Research.

Transposition of a Colon Segment as a Gastric Reservoir after Total Gastrectomy. (Preliminary Report) C. MARSHALL LEE, JR., M.D., Cincinnati. Department of Surgery, University of Cincinnati College of Medicine.

Experimental Studies on Peptic Ulceration and Stricture of the Lower Esophagus. H. ROBERT RIPLEY, M.D., W. V. LEARY, M.D., J. H. GRINDLAY, M.D., M.S.(Surg.), F.A.C.S., W. D. SEYBOLD, M.D., Rochester. Mayo Foundation for Medical Education and Research.

Neurosurgery

2:00 p.m., Wednesday—Ballroom, Hotel Statler

HOWARD C. NAFFZIGER, M.D., F.A.C.S., San Francisco; Professor of Surgery, University of California Medical School, Presiding.

Some Aspects of Experimental Psychosurgery. KARL E. PRIBRAM, M.D., New Haven. Yale University School of Medicine.

The Fronto-Cortico-Pontile Tract in Man; Functional Inconsequence of Its Surgical Interruption. RUSSELL MEYERS, M.D., F.A.C.S., Iowa City. Division of Neurosurgery, Department of Surgery, State University of Iowa College of Medicine.

Cortical Stimulation and Ablation Studies in Chronic Experimental Hypertension. HERBERT C. JOHNSON, M.D., KENNETH M. BROWNE, M.D., Baltimore. Division of Neurological Surgery, Johns Hopkins University School of Medicine.

Autonomic Effects Induced by Stimulation of the Frontal and Temporal Lobes in Man. JOSEPH RANSOHOFF, M.D., MURRY GLUSMAN, M.D., J. LAWRENCE POOL, M.D., F.A.C.S., New York. Neurological Institute.

Effect of Thalamotomy and Pollidotomy upon Involuntary Movements in Choreo-Athetosis. H. T. WYCIS, M.D., F.A.C.S., and E. A. SPIEGEL, M.D., Philadelphia. Departments of Experimental Neurology and Neurosurgery, Temple University School of Medicine.

The Effect of Prefrontal Lobotomy on Peptic Ulcer. JOHN T. B. CARMODY, M.D., F.A.C.S., Boston. Massachusetts General Hospital.

Therapeutic Value of Tracheotomy in Neurosurgery with Special Reference to Severe Craniocerebral Trauma. E. W. SKWAROK, M.D., G. L. MALTBY, M.D., Portland, Maine. Department of Neurosurgery, Maine General Hospital.

Some Observations on Intra-Carotid Blood Pressure Made During Carotid Ligation for Intracranial Aneurysms and During Arteriography. LESTER MOUNT, M.D., CHARLES E. BRACKETT, JR., M.D., New York. Neurological Institute.

An Anatomical Consideration of the Surgical Approach to the Cerebellopontile Angle with Particular Reference to the Venous Anatomy. RUDOLPH JAEGER, M.D., Philadelphia. Jefferson Medical College and Hospital.

Ventriculomastoidostomy in Hydrocephalus. WILLIAM A. NOSIK, M.D., F.A.C.S., Cleveland.

Ultrasonic Irradiation of Nervous Tissue. G. D. LUDWIG, M.D., H. T. BALLANTINE, JR., M.D., Boston. Massachusetts General Hospital and Massachusetts Institute of Technology.

Brain Revascularization after Carotid-Jugular Anastomosis Assessed by Angiography. I. M. TARLOV, M.D., M.Sc., F.A.C.S., B. S. SHUER, M.D., B. S. EPSTEIN, M.D., E. HIRSCH, M.D., R. MISSEN, M.D., New York. Department of Neurosurgery, New York Medical College.

Neurosurgery

9:00 a.m., Thursday—Ballroom Foyer, Copley Plaza Hotel

WILLIAM JASON MIXTER, M.D., F.A.C.S., Boston; Lecturer in Neurosurgery, University of Harvard Medical School, Presiding.

The Clinical Use of Radioactive Di-Iodo-Fluorescein in the Diagnosis and Localization of Tumors of the Central Nervous System. LOYAL DAVIS, M.D., F.A.C.S., JOHN MARTIN, M.D., F.A.C.S., MOSES ASHKENAZY, M.D., GEORGE V. LEROY, M.D., THEODORE FIELDS, B.S., Chicago. Department of Surgery, Northwestern University Medical School.

The Distribution of Radioactive Phosphorus in Normal and Diseased Brain Tissue. Experimental and Clinical Observations. W. EUGENE STERN, M.D., CURTIS MARSHALL, M.D., Baltimore. Department of Neurological Surgery, Johns Hopkins Hospital.

Studies on the External Localization of Brain Lesions Using Radioactive Potassium. ANTHONY F. SUSEN, M.D., WILFRED T. SMALL, M.D., FRANCIS D. MOORE, M.D., F.A.C.S., Boston. Surgical and Neurosurgical Services and Laboratories, Harvard Medical School, Children's Hospital and Peter Bent Brigham Hospital.

Studies in Formation, Circulation, and Absorption of Cerebrospinal Fluid. II. Studies With Heavy Water. WILLIAM H. SWEET, M.D., BERTRAM SELVERSTONE, M.D., SIDNEY SOLOWAY, M.D., DEWITT STETTEN, JR., Boston. Department of Surgery, Harvard Medical School, Neurosurgical Service of Massachusetts General Hospital and Division of Nutrition and Physiology, Public Health Research Institute of the City of New York, Inc.

Radioactive Potassium, a New Isotope for the Localization of Brain Tumors. BERTRAM SELVERSTONE, M.D., WILLIAM H. SWEET, M.D., and RICHARD J. IRETON, M.D., Boston. Massachusetts General Hospital.

Experiences with the Moore Technique of Localization of Cerebral Tumors with Radioactive Substances. EDWARD B. SCHLESINGER, M.D., New York. Neurological Institute, Presbyterian Hospital and Columbia University College of Physicians and Surgeons.

Spinal Puncture Headaches. URBAN H. EVERSOLE, M.D., and WILFRED J. ROKOWSKI, M.D., Boston. Department of Anesthesiology, The Lahey Clinic.

The Activity of Smooth Muscle After Sympathectomy. HOMER D. KIRGIS, M.D., ADRIAN F. REED, M.D., and JOHN Y. PEARCE, M.D., New Orleans. Sections on Neurosurgery and Surgery, Ochsner Clinic and Departments of Anatomy and Surgery, Tulane University School of Medicine.

The Recurrence of Vasoconstrictor Activity Following Limb Sympathectomy. CHARLES W. ROBERTSON, M.D., REGINALD H. SMITHWICK, M.D., F.A.C.S., Boston. Department of Surgery, Boston University School of Medicine and Massachusetts Memorial Hospitals.

Modified Surgical Treatment in Hypertension. DAVID CLEVELAND, M.D., M.S., Ph.D., F.A.C.S., Milwaukee. Department of Neurosurgery, Marquette University School of Medicine.

Alterations in Skin Temperature of the Toes During Lumbar Sympathectomy. ARTHUR F. O'KEEFFE, M.D., ROBERT C. HILL, M.D., RICHARD WARREN, M.D., F.A.C.S., West Roxbury, Massachusetts. Veterans Administration Hospital.

The Effect of Stellate Ganglion Block and Cervical Sympathectomy upon the Cerebral Blood Flow and Vascularity of the Cerebral Cortex Measured by the Nitrous Oxide Method and Radioactive Colloids (Y^{90}). JOHN E. ADAMS, M.D., San Francisco. University of California Medical School.

Liver and Bile Ducts, Portacaval Anastomosis and Kidney

9:00 a.m., Thursday—Ballroom, Copley Plaza Hotel

WARREN H. COLE, M.D., F.A.C.S., Chicago; Professor of Surgery, University of Illinois College of Medicine, Presiding.

The Experimental Production of the Hepatorenal Syndrome in Dogs. D. STATE, M.D., F.A.C.S., J. MULLER, M.D. and ROBERT RAUCH, M.D., Minneapolis. Department of Surgery, University of Minnesota School of Medicine.

Experimental Production of Liver Cirrhosis in Male Rats by 2-Acetyl-Amino-Fluorene. STANLEY C. SKORYNA, D. R. WEBSTER, M.D., Ph.D., F.R.C.S.(C), Montreal. Department of Experimental Surgery, McGill University Faculty of Medicine.

The Nature of Hepatic Failure Complicating Surgery of the Gall Bladder and Bile Ducts. J. ENGLEBERT DUNPHY, M.D., F.A.C.S., J. HARTWELL HARRISON, M.D., JOHN MERRILL, M.D., Boston. Surgical Services and Surgical Laboratories of Harvard Medical School at Peter Bent Brigham Hospital.

Use of the Left Hepatic Duct to By-Pass Defects in the Common Bile Duct. CHARLES S. ROGERS, M.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania School of Medicine.

Hepatic Artery Ligation and Liver Protein Regeneration. G. M. KARN, M.D., H. M. VARS, Ph.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania School of Medicine.

Effects of Occlusion of the Hepatic Artery and Portal Vein in Dogs. FRANCISCO L. RAFFUCCI, M.D., Minneapolis. Department of Surgery, University of Minnesota Medical School.

Observations on the Major Radicals of the Portal System. A Synopsis. H. K. PURCELL, M.D., J. J. CONNOR, M.D., WILLIAM F. ALEXANDER, M.D., N. M. SCULLY, M.D., St. Louis. Departments of Surgery and Anatomy, St. Louis University School of Medicine.

Observations Following Interference With Hepatic Blood Supply. MARION S. DEWEESE, M.D., F.A.C.S., CLAYTON LEWIS, JR., M.D., Ann Arbor. Department of Surgery, University of Michigan Medical School.

The Significance of Decreased Dye Clearance by the Liver Following Porto-Caval Anastomosis. JOHN F. LAWS, M.D., TILDEN C. EVERSON, M.D., Chicago. Department of Surgery, University of Illinois College of Medicine.

The Experimental Use of Vascular Grafts in Porto-Caval Anastomosis. HARRY W. SOUTHWICK, M.D., WARREN H. COLE, M.D., F.A.C.S., Chicago. Department of Surgery, University of Illinois College of Medicine.

The Significance of Esterified Cholesterol. JAMES M. HARMON, M.D., MADELAINE B. MEANS, B.S., JOHN W. MEANS, M.D., C. JOSEPH DELOR, M.D., Columbus. Division of Gastroenterology, Department of Medicine and Surgery, Ohio State University College of Medicine.

Effects of Chronic Constriction of the Thoracic Aorta on Renal Dynamics. W. GLENN YOUNG, JR., M.D., W. C. SEALY, M.D., JEROME HARRIS, M.D., Durham. Division of Thoracic Surgery and Department of Pediatrics, Duke University School of Medicine.

Wounds and Wound Healing, Tissue Transplantation, Antiseptics and Antibiotics

9:00 a.m., Thursday—New England Mutual Hall

MICHAEL L. MASON, M.D., F.A.C.S., Chicago; Professor of Surgery, Northwestern University Medical School, Presiding.

The Influence of Cooling on the Survival of the Ischemic Extremity. JACK S. PARKER, M.D., C. STUART WELCH, M.D., Boston. Department of Surgery, Tufts College Medical School and New England Center Hospital.

The Effect of Various Enzymes on Infected Wounds and Necrotic Tissue. SIDNEY E. ZIFFREN, M.D., F.A.C.S., SAM C. MAY, M.D., Iowa City. Department of Surgery, State University of Iowa College of Medicine.

Wound Healing. R. W. WILLIAMS, M.D., H. H. BRADSHAW, M.D., Winston-Salem. Bowman Gray School of Medicine of Wake Forest College.

A Histological Study of Wound Healing and Its Relationship to Cortisone and Serum Antihyaluronidase. JACK W. COLE, M.D., J. LOWELL ORBISON, M.D., WILLIAM D. HOLDEN, M.D., F.A.C.S., THOMAS HANCOCK, M.D., JOHN L. LINDSAY, M.D., JAY L. ANKENEY, M.D., CHARLES A. HUBAY, M.D., Cleveland. Departments of Surgery and Pathology, Western Reserve University School of Medicine and Laboratory of Surgical Research, University Hospitals.

Experimental Work in the Homotransplantation of Skin. WILLIAM S. KISKADDEN, M.D., F.A.C.S., DONALD E. BARKER, M.D., Los Angeles. Department of Surgery, University of Southern California, Los Angeles and Birmingham Veterans Hospital, Van Nuys, California.

An Experimental Study of Refrigerated Skin Grafts Stored in Ten Percent Serum. A. G. MARRANGONI, M.D., Bethesda, Maryland. Naval Medical Research Institute. National Naval Medical Center.

The Use of Gelatinized Bone, a Preliminary Report. WILSON A. SWANKER, M.D., New York. Department of Surgery, New York Medical College.

A Study on Bone Growth. ROSCOE S. MOSIMAN, M.D., New Orleans. Department of Surgery, Tulane University School of Medicine.

An Experimental Study of the Properties of Powdered Gelatin Sponge and a Gelatin Film in the Tissues. DOUGLAS PACKARD, M.D., HILGER PERRY JENKINS, M.D., F.A.C.S., Chicago. Department of Surgery, University of Illinois College of Medicine and Woodlawn Hospital.

Neomycin, an Intestinal Antiseptic. EDGAR J. POTH, Ph.D., M.D., F.A.C.S., S. M. FROMM, M.D., R. I. WISE, Ph.D., Galveston. University of Texas Medical Branch.

The Intestinal Flora in Relationship to the Newer Antibacterial Agents. J. B. GANEY, M.D., A. R. MANSBERGER, M.D., E. R. SHIPLEY, M.D., G. H. YEAGER, M.D., T. E. WOODWARD, M.D., Baltimore. Departments of Surgery and Medicine, University of Maryland School of Medicine and College of Physicians and Surgeons.

Experimental Evaluation of Intestinal Antiseptics When Used for Protection From Fecal Contamination During Colon Resection. J. MALCOLM EDMISTON, M.D., O. G. DAVIES, M.D., THOMAS LEDWICH, M.D., FLOYD MARCHI, M.D., MELBA SHAFER, M.D., H. J. MCCORKLE, M.D., F.A.C.S., San Francisco. The Experimental Surgery Laboratories, University of California School of Medicine.

The Local Use of Streptokinase and Streptodornase in Suppurative Tuberculous Adenitis. GEORGE N. HAZLEHURST, M.D., New York. Department of Medicine, New York University College of Medicine and Third Medical Division, Bellevue Hospital.

The Local Use of Streptokinase and Streptodornase in Refractory Chronic Draining Sinuses. SOL SHERRY, M.D., New York. Department of Medicine, New York University College of Medicine and Third Medical Division, Bellevue Hospital.

Anesthesia

1:15 p.m., Thursday—Ballroom Foyer, Copley Plaza Hotel

HENRY K. BEECHER, M.D., Boston; Professor of Research in Anesthesia, Harvard Medical School, Presiding.

A Simplified Respirator for Mechanical Control of Respiration in Open Chest Operations. CLARENCE DENNIS, M.D., F.A.C.S., RUSSELL M. NELSON, M.D., W. P. EDER, M.D., KARL KARLSON, M.D., Minneapolis. Department of Surgery, University of Minnesota Medical School.

A Device Producing Regulated Assisted Respiration: Its Effect on Hypoventilation in Thoracic Surgery. JAMES V. MALONEY, JR., M.D., WILLIAM S. DERRICK, M.D., JAMES L. WHITTENBERGER, M.D., Boston. Department of Physiology, Harvard School of Public Health and Department of Surgery (Anesthesiology), Peter Bent Brigham Hospital.

Emergency Artificial Respiration with Blood Gas Studies. ROBERT F. JONES, BEN WILSON, M.D., GEORGE P. SHROPULOS, M. T. JENKINS, M.D., Dallas. Department of Experimental Surgery, Southwestern Medical School of The University of Texas.

Evaluation of Carbon Dioxide Accumulation in Anesthetized Patients Utilizing a Portable Mass Spectrometer to Analyze Exhaled Gaseous Concentrations. FLETCHER A. MILLER, M.D., ALLAN HEMINGWAY, M.D., E. B. BROWN, M.D., A. O. NIER, M.D., RALPH KNIGHT, M.D., RICHARD L. VARCO, M.D., Minneapolis. University of Minnesota Medical School.

Changes in Acid-Base Balance in Prolonged Anesthesia in Clinical Patients. W. P. EDER, M.D., GEORGE KRAEMER, M.D., CLARENCE DENNIS, M.D., F.A.C.S., Minneapolis. Department of Surgery, University of Minnesota Medical School.

The Effect of Posture and of Anoxia on Cardiac Output in the Normal Human Subject. WALTER S. COE, M.D., MAURICE M. BEST, M.D., HAMPDEN C. LAWSON, M.D., Louisville. University of Louisville Institute for Medical Research.

The Effects of Pentothal and Curare upon Central Respiratory Control Mechanisms. M. T. JENKINS, M.D., Dallas. The Department of Experimental Surgery, Southwestern Medical Schools of The University of Texas and Department of Anesthesia, Parkland Hospital.

Cardiovascular Responses to Endotracheal Intubation During Light Anesthesia. BENTON D. KING, M.D., LEROY C. HARRIS, JR., M.D., FERDINAND E. GREIFENSTEIN, M.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania School of Medicine and Department of Anesthesiology, Hospital of the University of Pennsylvania.

Mechanism of Arterial Hypotension Associated with Cyclopropane Anesthesia. ROBERT D. O'MALLEY, M.D., JACK M. FRUMIN, M.D., New York. Columbia University College of Physicians and Surgeons.

Changes in the Sympathectomized Extremity During Anesthesia. DAVITT A. FELDER, M.D., ROBERT R. LINTON, M.D., DONALD P. TODD, M.D., CATHERINE BANKS, B.S., Boston. Peripheral Vascular Laboratory and Department of Anesthesia, Massachusetts General Hospital.

The Use of Postoperative Pain in Determining the Potency of Analgesics. ARTHUR S. KEATS, M.D., and HENRY K. BEECHER, M.D., Boston. Anesthesia Laboratory, Harvard Medical School at Massachusetts General Hospital.

Water, Electrolytes and Protein, Preoperative and Postoperative Care

9:00 a.m., Friday—Ballroom Assembly, Hotel Statler

CARL A. MOYER, M.D., F.A.C.S., Dallas; Professor of Surgery, Southwestern University Medical College, Dallas, Presiding.

Endocrine Mechanisms Concerned in Postoperative Electrolyte Changes. BERNARD ZIMMERMANN, M.D., Minneapolis. Department of Surgery, University of Minnesota Medical School.

The Effect of Age, Sex, and Disease States upon Total Body Water in the Human Subject. BENT J. FRIIS-HANSEN, M.D., PAUL R. SCHLOERB, M.D., DAVID SHELDON, M.D., ISIDORE S. EDELMAN, M.D., FRANCIS D. MOORE, M.D., F.A.C.S., Boston. Surgical Services and Surgical Laboratories of Harvard Medical School at Peter Bent Brigham Hospital.

Studies of Variations in Osmotic Equilibrium, Acid-Base Equilibrium and Fluid Volumes in Nephrectomized Dogs After Infusions of Electrolyte Solutions of Varying Composition and Concentration. R. E. KEATING, M.D., THEO. E. WEICHSELBAUM, M.D., R. ELMAN, M.D., F.A.C.S., St. Louis. Department of Surgery, Washington University School of Medicine.

The Use of the Water-Chloride Balance Sheet in the Management of Fluid Balance Problems. B. H. SCRIBNER, M.D., C. F. GASTINEAU, M.D., M. H. POWER, Ph.D., J. T. PRIESTLEY, M.D., Rochester. Mayo Foundation for Medical Education and Research.

Potassium Metabolism in the Postoperative Patient. HOWARD C. HEWITT, M.D., Ann Arbor. Department of Surgery, University of Michigan Medical School.

Factors Influencing the Postoperative Excretion of Salt and Water and Further Studies of the Relation of Body Fluid Compartments to Body Fat. JAMES D. HARDY, M.D., P. K. SEN. M.B., M.S., DAVID L. DRABKIN, M.D., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania Schools of Medicine, Department of Physiological Chemistry, Graduate School of Medicine and Surgical Clinic, Hospital of the University of Pennsylvania.

Studies with a Method for the Colorimetric Determination of Lipase in Serum and Urine. ARNOLD M. SELIGMAN, M.D., and PHILIP GLOTZER, M.D., Boston. Beth Israel Hospital and Harvard Medical School.

The Importance of Fat as a Source of Calories in Surgical Patients. EDWIN H. ELLISON, M.D., ROBERT M. ZOLLINGER, M.D., MARY MARTIN, M.D., JOHN B. BROWN, Ph.D., Columbus. Department of Surgery and Physiological Chemistry, Ohio State University College of Medicine.

The Effect on Nitrogen Retention as the Result of Administering Phosphate Ion With Amino Acids Intravenously. DAVID V. HABIF, M.D., HENRY T. RANDALL, M.D., SIDNEY C. WERNER, M.D., JOHN S. LOCKWOOD, M.D., Med.Sc.D., (Surg.), F.A.C.S. (deceased), New York. Department of Surgery, Columbia University College of Physicians and Surgeons.

The Effect of Pathophysiological States on the Rate of Disappearance of Radioactive Protein from the Blood Stream. CHARLES A. HUBAY, M.D., HARVEY KRIEGER, M.D., WILLIAM D. HOLDEN, M.D., F.A.C.S., THOMAS J. HANCOCK, M.D., Cleveland. Department of Surgical Research, Western Reserve University School of Medicine and Department of Surgery, University Hospitals of Cleveland.

Antibody Formation in Malnourished Patients. HENRY H. BALCH, M.D., New York. Department of Surgery, New York University College of Medicine.

Evaluation of Preoperative Skin Preparation: Chick Embryo and Animal Studies. J. J. MURPHY, M.D., J. A. DULL, M.D., HELEN ELLIS, B.A., J. A. GAMBLE, B.S., C. T. FULTZ, B.S., H. A. ZINTEL, M.D., D.Sc.(Med.), F.A.S.C., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania Schools of Medicine.

Evaluation of Preoperative Skin Preparations. Human Studies, H. A. ZINTEL, M.D., D.Sc.(Med.), F.A.C.S., J. J. MURPHY, M.D., J. A. DULL, M.D., C. T. FULTZ, B.S., J. A. GAMBLE, B.S., HELEN ELLIS, B.A., Philadelphia. Harrison Department of Surgical Research, University of Pennsylvania Schools of Medicine.

Malignancies, Endocrines and Miscellaneous

9:00 a.m., Friday—Ballroom, Hotel Statler

C. STUART WELCH, M.D., F.A.C.S., Boston; Professor of Surgery, Tufts College Medical School, Presiding.

Does the Sertoli Cell Produce Estrogen? A Histochemical Study of Secretory Activity. K. M. LYNCH, JR., M.D., Baltimore. Department of Urology, Johns Hopkins University School of Medicine.

Exploration Following Resection of the Colon, Rectum or Stomach for Carcinoma With Lymph Node Metastases. F. JOHN LEWIS, M.D., Minneapolis. Department of Surgery, University of Minnesota School of Medicine.

The Toxicity of Malignant Serum for Paramecium Caudatum. RICHARD W. EGAN, M.D., Damon Runyon Clinical Research Fellow, Buffalo. Surgical Research Laboratory, Buffalo General Hospital and Department of Surgery, University of Buffalo School of Medicine.

Tracer Studies of Radioactive Sodium Estrone Sulfate in Cases of Advanced Breast Cancer. EDWARD F. LEWISON, M.D., F.A.C.S., GEORGIANNA S. JONES, M.D., J. ELLIOT LEVI, M.D., HOWARD W. JONES, JR., M.D., HANNAH SILBERSTEIN, Baltimore. Departments of Surgery and Gynecology, Johns Hopkins Hospital and Departments of Medicine and Surgery, Sinai Hospital.

Studies on a Nonvirilizing Steroid Effective in the Palliation of Breast Cancer. F. HOMBURGER, M.D., S. C. KASDON, M.D., W. H. FISHMAN, Ph.D., Boston. Department of Surgery, Tufts College Medical School.

A Study of Labelled Phosphorous in Cancer of the Cervix. SOMERS H. STURGIS, M.D., F.A.C.S., NORMAN GOLD, Ph.D., Boston. Department of Surgery, Massachusetts General Hospital.

The Influence of the Adrenal Cortex on the Growth of Fibrosarcoma in Mice. CHARLES E. FRIEDGOOD, M.D., Brooklyn. Department of Surgery, Maimonides Hospital and State University Medical Center, New York.

Ninety-Five Percent Subtotal Adrenalectomy for Essential Hypertension: Case Report. HAROLD A. ZINTEL, M.D., D.Sc.(Med.), F.A.C.S., CHARLES C. WOLFERTH, M.D., WILLIAM A. JEFFERS, M.D., JOSEPH H. HAFKENSCHIEL, M.D., F. D. W. LUKENS, M.D., Philadelphia, Surgical Clinic and Medical Service, University of Pennsylvania Hospital.

The Effect of Thiocyanates on the Adrenal Cortex of Experimental Hypertensive Animals. JOSEPH TARKINGTON, M.D., CARLOS A. TANTURI, M.D., LOYAL DAVIS, Ph.D., M.D., D.Sc., F.A.C.S., Chicago. Department of Surgery, Northwestern University Medical School.

Studies of Hepatic Inactivation of Androgen. J. T. GRAYHACK, M.D., Baltimore. Department of Urology, Johns Hopkins University School of Medicine.

Experimental and Clinical Studies on the Use of Iodothiouracil as an Anti-Thyroid Agent. C. R. HEIDENREICH, M.D., E. F. FOWLER, M.D., Chicago. Department of Surgery, University of Illinois College of Medicine.

Homologous Transplantation of Fetal Endocrine Tissue. JOSEPH T. DAMERON, M.D., Buffalo. Surgical Research Laboratory of the Buffalo General Hospital and Department of Surgery, University of Buffalo School of Medicine.

The Effect of Penicillin and Streptomycin upon the Sciatic Nerve of the Cat. RAY BROADBENT, M.D., JEROME JAVER, M.D., BARNES WOODHALL, M.D., Durham. Neurosurgical Division, Duke Hospital and Duke University School of Medicine.

Aureomycin in the Treatment of Amebiasis: Clinical Application in Intestinal Surgery. LEON V. MCVAY, JR., M.D., Memphis. Division of Medicine, University of Tennessee College of Medicine.

Changes in Circulating Eosinophiles Following Surgery Under General and Regional Anesthesia. A. H. STEIN, M.D., W. B. WALKER, M.D., G. CHAMBERLAIN, M.D., R. ELMAN, M.D., F.A.C.S., St. Louis. Department of Surgery, Washington University School of Medicine.

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